Analecta
REVIEW OF FACULTY OF ENGINEERING
Analecta Technica Szegedinensia
ISSN 2064-7964

Vol. 12, No. 2 **2018**

THE MAGNETIZATION OF DENSE AGGREGATED DIPOLAR FLUIDS

Sándor Nagy
Institute of Mechatronics Engieering and Research, Gasparich M. u. 18/A, 8900, Zalaegerszeg, Hungary,
e-mail:sata123.sandor@gmail.com

ABSTRACT

The magnetization for dipolar fluids is studied treated separately at low and high external magnetic field. Canonical ensemble Monte Carlo simulations have been performed in dipolar hard sphere fluid in order to test these theoretical results. New expressions are introduced at low and high external field and ultimately the synthesized formula is given. The main difference in the structure of dipolar liquids at different external field is the average orientation of the formed chains. In case of infinitesimal external magnetic field there is no a well-specified direction, while at high enough external field actually the chains are parallel to this field. The present theory yields good result in the intermediate region as well where the most conspicuous failures are provided by the former theories.

Keywords: dipolar fluids, magnetization, ferrofluids, Monte Carlo simulation

1. INTRODUCTION

1.1 The effective field

There are several relevant theories for the magnetization of dipolar fluids. These differ from each other mainly that in the expression of magnetization that

$$M = \rho m L\left(\frac{mH_e}{k_B T}\right) \tag{1}$$

the H_e effective field is determined differently. Hereinafter the mH/k_BT type argument in the L Langevin function will be denoted by α. The index of α will be the same as index of H magnetic field. In (1) M is the magnetization, ρ is the number density, m is the dipole moment, k_B is the Boltzmann constant, and T is the temperature. According to the Langevin theory [1] the effective magnetic field is equal to the external magnetic field:

$$H_e = H_0 \tag{2}$$

i.e. it does not take into account the field strength from adjacent particles. In his forward theory, Weiss [2] has gave an implicit expression to H_e:

$$H_e = H_0 + \frac{4\pi}{3}\rho m L(\alpha_e) \tag{3}$$

DOI: 10.14232/analecta.2018.2.1-12

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REVIEW OF FACULTY OF ENGINEERING
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Here the effective field is equal to the sum of external field and additional field from the surrounding particles. This leads to the outcome, that the effective field is not equal to zero when the external field is zero, which is obviously incorrect. Although Pschenichnikov [3] has made a small change in the argument of Langevin function, but the divergence disappeared:

$$H_e = H_0 + \frac{4\pi}{3}\rho m L(\alpha_0) \tag{4}$$

Equation (4) describes well the magnetization at low density and dipole moment, although at low external field underestimates and at high external field overestimates the simulation data. Ivanov [4] completes the second term in (4) in order to that the results at low external magnetic field get closer to the simulations. This has more or less succeeded but in this case (5) even more overestimates the simulations at high external magnetic field:

$$H_e = H_0 + \frac{4\pi}{3}\rho m L(\alpha_0)\left[1 + \frac{4\pi}{48}\frac{\partial\left(\rho m L(\alpha_0)\right)}{\partial H_0}\right] \tag{5}$$

On Fig. 1 the curves of effective field according to some former theory are presented in function of external field at four different values of density and dipole moment. Furthermore the simulation values of effective field are marked also by the help of (1) calculated from the simulation values of magnetization. Now and hereafter on the figures the reduced units are used, defined by these expressions: $\rho^* = \rho\sigma^3$, $m^* = m/\sqrt{\sigma^3 k_B T}$, $M^* = M\sqrt{\sigma^3/k_B T}$, $H^* = H\sqrt{\sigma^3/k_B T}$. (The σ is the diameter of particles of monodisperse dipolar hard sphere system.)

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REVIEW OF FACULTY OF ENGINEERING
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ISSN 2064-7964

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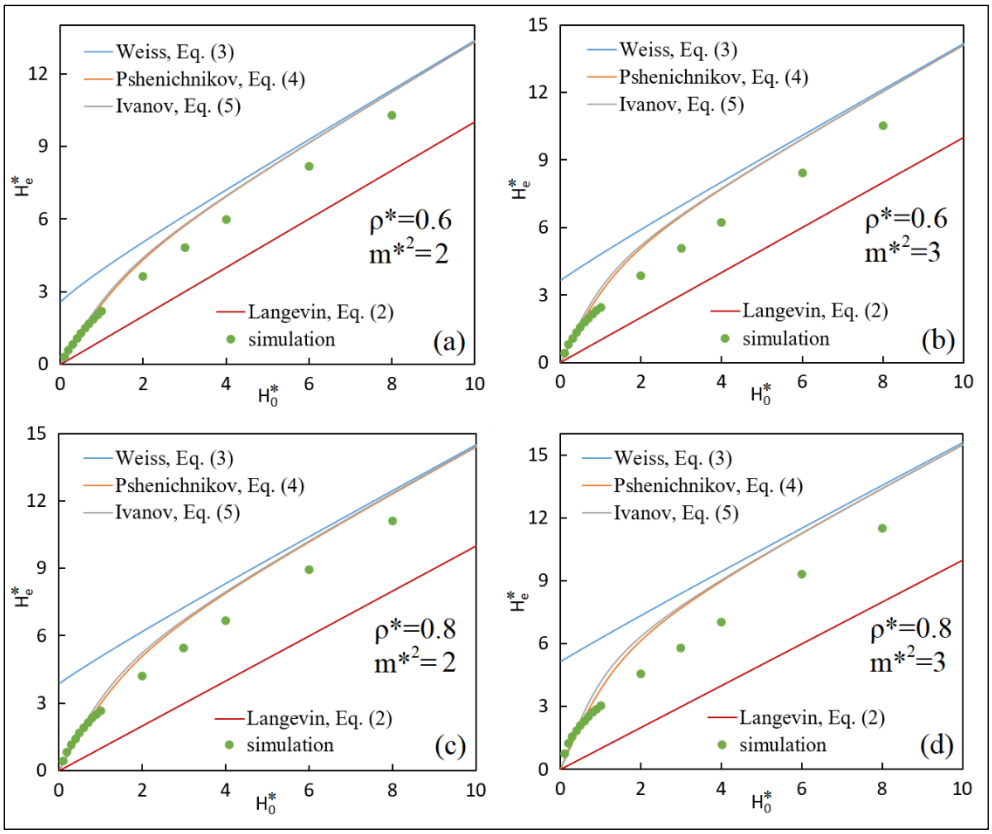

Figure 1. The values of effective magnetic field in function of external magnetic field in case of four former theories and simulation.

It is clearly shown on Fig. 1, that in all four cases there are significant difference between the simulation and theoretical data for both large and small external field. As the external field and thus the effective field increases, in the magnetization this difference disappears ever since the magnetization goes to saturated. All three relevant theories (Weiss, Pshenichnikov, Ivanov) as shown in Fig. 2 lead to the same value of magnetization, when $H_0 \to \infty$. There are even more theories for the magnetization of dipolar fluids, which have approached the experimental and simulation values with more or less success [5-9].

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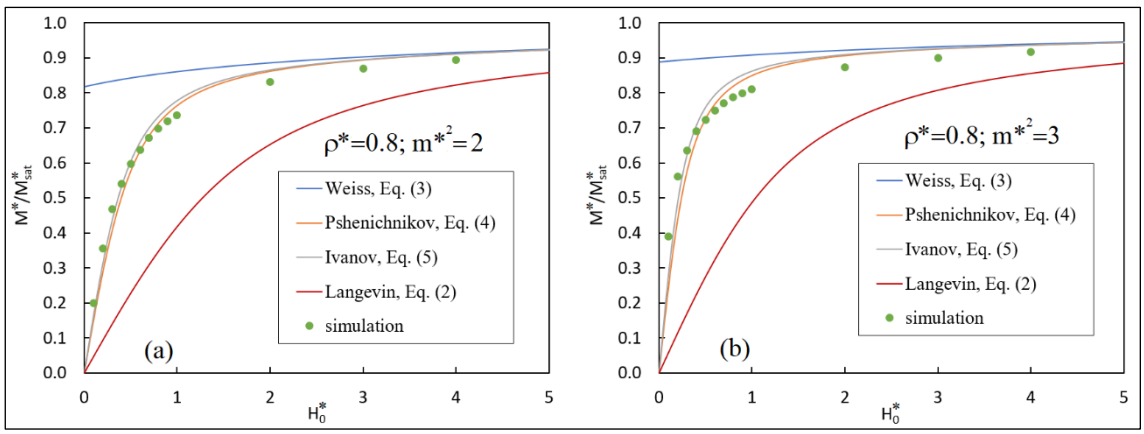

Figure 2. The values of magnetization curve in function of external magnetic field in case of four former theories and simulation.

1.2 The closure of effective field at zero external field

For the initial susceptibility of dense dipolar fluids recently Nagy [10] has given new theoretical results. The new method is based on that dipoles are chained already at zero external field. The chain and particle distribution can be calculated according to the geometric distribution. The chain distribution is

$$g_k = qp^{k-1} \tag{6}$$

where p is the probability of chaining between two adjacent, parallel particles, are under the influence of local magnetic field, while $q = 1 - p$, and k is the length of the chain. The particle distribution specifies the proportion of particles involved in k length chains:

$$h_k = q^2 k p^{k-1} \tag{7}$$

According to this theory the initial magnetic susceptibility can be calculated as follows:

$$\chi = \frac{1+p}{1-p}\chi_L\left(1 + \frac{4\pi}{3}\chi_L\right) \tag{8}$$

where $\chi_L = \rho m^2/3k_BT$ is Langevin susceptibility. For dipolar hard sphere system the values of p to different densities and dipole moments are given in Tab. 1 [10]. The initial susceptibility given by (8) can be obtained from the expression $\chi = \partial M/\partial H_0$ at zero external field, if the effective field is replaced by the following in (1):

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$$H_e = \frac{1+p}{1-p}\left(H_0 + \frac{4\pi}{3}\rho m L(\alpha_0)\right) \quad (9)$$

Equation (9) ensures that the initial part of the magnetization curve starts with the required slope. Although at higher external field even more overestimates the simulations like any of the former theories.

Table 1. The probability of the chaining formation at three different dipole moments and wide range of density.

	p		
ρ*	**m*=1**	**m*=$2^{0.5}$**	**m*=$3^{0.5}$**
0.1	0.000260	0.000263	0.000580
0.2	0.000426	0.000429	0.000943
0.3	0.000615	0.000617	0.00794
0.4	0.000852	0.00292	0.0250
0.5	0.00117	0.0110	0.0521
0.6	0.00164	0.0253	0.0953
0.7	0.00241	0.0515	0.170
0.8	0.0135	0.107	0.320
0.85	0.0269	0.164	0.471
0.9	0.0539	0.273	0.649

2. THEORY

2.1 The approach of effective field at high external field

As mentioned above, except the Langevin theory the former approaches overestimates the magnetization at high external magnetic field. For describing the magnetization in all range of external field a new, correct expression has to be found at high external field, then the formulas which have concerned to the low and high external field has to be put together. The general failure of the previous theories were just that those lumped together the magnetization in the all range. At low external field with appropriate parameters the chains are formed, but do not stand in the direction of this field. Nevertheless at high external field the direction of chains is parallel to this external field. The overestimating of magnetization may also come from that the former approaches the particles regard as Lm sized, fixed, external field parallel particles, instead of m sized, swinging ones. In the following a new modification of the effective field will be introduced, which decreases the magnetization at high external field.

It is noticeable from Fig. 1, that decreasing the $4\pi/3$ factor by an appropriate value in (1) the simulation data could be reproduced at high external field. The question is the rate of this reduction. At low density and dipole moment there is no need to reduce it at all, and higher density and dipole moment as shown on Fig. 1, should be reduced in a different value. For this, consider Fig. 3, where the values of effective field of Weiss theory (3) are plotted in negative external field as well to two different dipole moments and four

DOI: 10.14232/analecta.2018.2.1-12

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REVIEW OF FACULTY OF ENGINEERING
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different densities. Interestingly that for negative external fields belong to positive effective field, which is presumably not a stable equilibrium state.

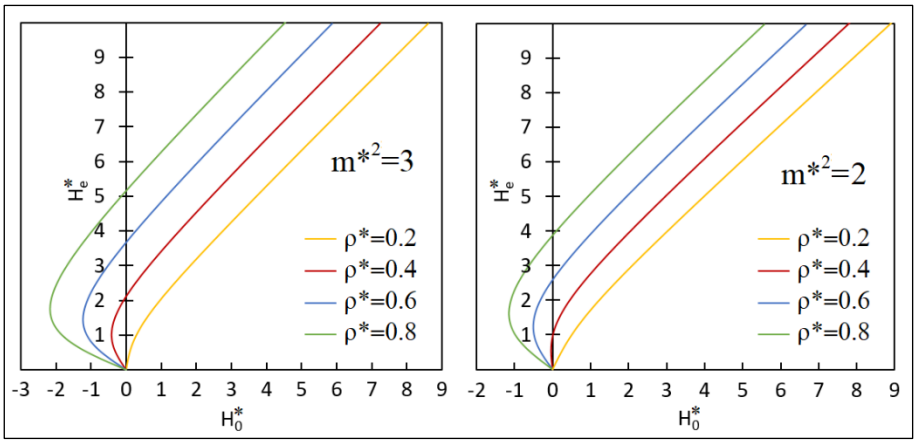

Figure 3. The values of effective magnetic field according to (3) in function of external magnetic field including the negative range at different densities and dipole moments.

The Weiss theory is applicable to approximate the simulation data at high external field if the curves are offset along the ordinate axis to negative direction on Fig. 3. Fig. 4 shows the rates of the offsets at $m^{*2} = 3$ dipole moment and three different densities: for each H_0 values must have belong to at most one H_e value. Let's sign by H_0' and H_e' the abscissa and ordinate of the point on the curve where its slope is infinite.

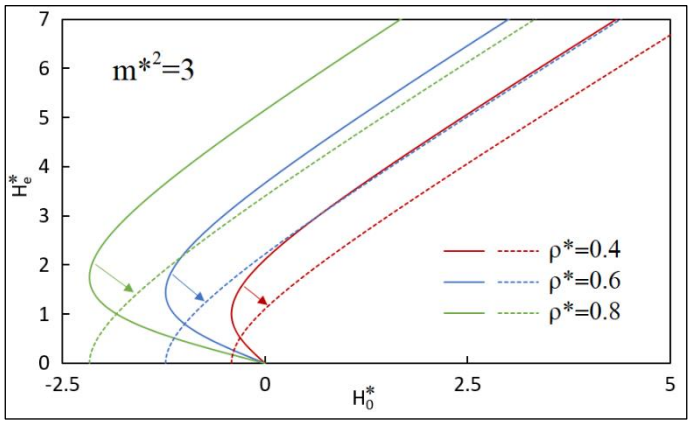

Figure 4. Examples for the extents of the offset. The dotted lines are well aproximated the simulation values of effective field

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The statement is that the rate of the mentioned offset is H_e', where H_e' is a function of m, ρ, and T. Thus (4) changes to the following expression at high external field:

$$H_e = H_0 + d\rho mL(\alpha_0) \tag{10}$$

The relation between H_e' and d constant is:

$$d = \frac{4\pi}{3} - \frac{H_e'}{\rho m} \tag{11}$$

The value of H_e' can be determined from the condition that derivative of the original function at H_0' becomes infinite, or by other words only at H_0' in the range $H_0 < 0$, the function $H_e(H_0)$ has only one value. In (3) the H_e effective field is the sum of H_0 external and H_p additional field:

$$H_e = H_0 + H_p \tag{12}$$

where

$$H_p = \frac{4\pi}{3}\rho mL(\alpha_0 + \alpha_p) \tag{13}$$

So the $H_0 = H_0'$ value is to be determined, where (13) has exactly one solution in the negative range. Let the left side be the function $f = f(H_p)$, while the right side is the function $g = g(H_p)$ and by plotting both in function of H_p, the solution of (13) is illustrativable (Fig. 5).

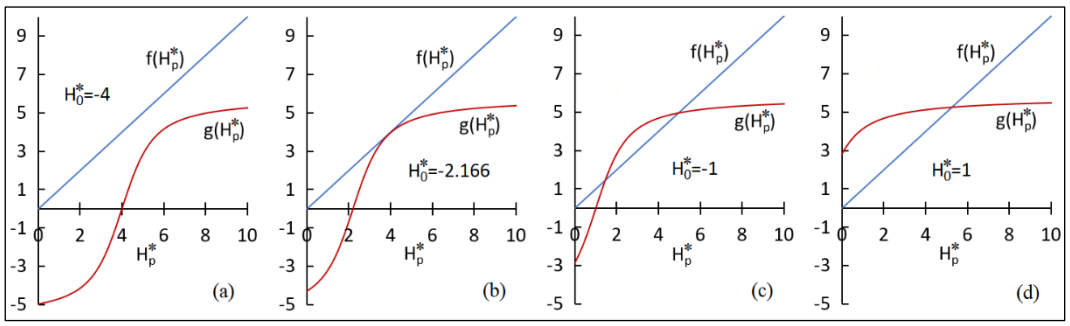

Figure 5. The graphical solution of (13). Changing the external magnetic field the number of solutions are also changing. 5.a: there is no solution if $H_0 < H_0'$; 5.b: there is only one solution, and the two curves are tangent to each other if $H_0 = H_0'$; 5.c: there are two solutions if $H_0' < H_0 \leq 0$; 5.d: there is only one solution and the two curves intersect each other if $H_0 > 0$.

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Since at H_0' the functions f and g are tangential therefore additional constraint can be determined for their differentials:

$$\frac{\partial f(H_p)}{\partial H_p} = \frac{\partial g(H_p)}{\partial H_p}\bigg|_{H_p=H_p'} = 1 \tag{14}$$

Performing the second operation, we get

$$\frac{4\pi}{3}\rho m^2\left(\alpha_e'^{-2} - \sinh^{-2}(\alpha_e')\right) = 1 \tag{15}$$

This equation has to be solved numerically for H_e'. Then substituting H_e' into (13) can also be obtained H_0' and H_p'. Furthermore, the d constant and the H_e function can be written according (11) and (10), and ultimately from (1) the magnetization can be approached in case of high external magnetic field.

Table 2. The values of $H_0'^*$ and $H_e'^*$ calculated numerically from (15) at three different dipole moments and wide range of density.

	m*=1		**m*=$2^{0.5}$**		**m*=$3^{0.5}$**	
ρ*	$H_0'^*$	$H_e'^*$	$H_0'^*$	$H_e'^*$	$H_0'^*$	$H_e'^*$
0.1	0	0	0	0	0	0
0.2	0	0	0	0	0	0
0.3	0	0	0	0	-0.1052	0.6387
0.4	0	0	-0.0410	0.5347	-0.4141	1.0055
0.5	0	0	-0.2401	0.9613	-0.7989	1.2507
0.6	0	0	-0.5072	1.2315	-1.2276	1.4438
0.7	0	0	-0.8141	1.4409	-1.6860	1.6069
0.8	-0.0579	0.7562	-1.1485	1.6159	-2.1664	1.7501
0.85	-0.1150	0.9495	-1.3238	1.6944	-2.4132	1.8162
0.9	-0.1823	1.1062	-1.5034	1.7683	-2.6638	1.8792

DOI: 10.14232/analecta.2018.2.1-12

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ISSN 2064-7964

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2.2 The synthesis of theories of the effective field

In section 1.2 and 2.1 the effective field has been written at zero and high external field by (9) and (10). Now the synthesis of these expressions is needed. For better comprehension let's introduce the functions $A = A(H_0)$ and $B = B(H_0)$. The effective field can be written:

$$H_e = A\big(H_0 + B\rho m L(\alpha_0)\big) \tag{16}$$

where:

$$A \to \frac{1+p}{1-p} \quad \text{and} \quad B \to \frac{4\pi}{3}, \quad \text{if} \quad H_0 \to 0 \tag{17a}$$

and

$$A \to 1 \quad \text{and} \quad B \to d, \quad \text{if} \quad H_0 \to \infty \tag{17b}$$

For these transitions the well-nown tanh function proved to be suitable with argument mH_0/k_BT. The transition to function A is implemented by the following expression:

$$A(H_0) = (1 - \tanh(\alpha_0))\left(\frac{1+p}{1-p} - 1\right) + 1 \tag{18}$$

After simple transformation can be written as

$$A(H_0) = \frac{1 + p - 2p\tanh(\alpha_0)}{1-p} \tag{19}$$

The applicable transition to function B is:

$$B(H_0) = (1 - \tanh(\alpha_0))\left(\frac{4\pi}{3} - d\right) + d \tag{20}$$

Similar to previous transitions function B is

$$B(H_0) = \frac{4\pi}{3} - \frac{H_e'}{\rho m}\tanh(\alpha_0) \tag{21}$$

In (16) function B is multiplied by the Langevin magnetization, which contains the coth function, since

$$L(x) = \coth(x) - \frac{1}{x} \tag{22}$$

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Due to the relationship between tanh and coth function the second part of (16) is:

$$B\rho mL(\alpha_0) = \left(\frac{4\pi}{3} - \frac{H_e'}{\rho m}\tanh(\alpha_0)\right)\rho mL(\alpha_0) = \frac{4\pi}{3}\rho mL(\alpha_0) + H_e'\left(\frac{\tanh(\alpha_0)}{\alpha_0} - 1\right) \tag{23}$$

Substituting (19) and (23) in (16) the final formula of the effective magnetic field is obtained:

$$H_e = \frac{1 + p - 2p\tanh(\alpha_0)}{1 - p}\left[H_0 + \frac{4\pi}{3}\rho mL(\alpha_0) + H_e'\left(\frac{\tanh(\alpha_0)}{\alpha_0} - 1\right)\right] \tag{24}$$

3. RESULTS AND DISCUSSION

Monte Carlo simulations have been performed for dipolar hard sphere fluids to determine the magnetization. The simulation values of the effective field are calculated from (1). We applied canonical *NVT* ensemble, Boltzmann sampling, periodic boundary conditions and minimum-image convention [11]. In order to take into account the long-ranged character of the dipolar interaction the reaction-field method was used. After 100.000 equilibration cycles, 1-3 million production cycles were used. The number of particles was $N = 512$. The magnetization was obtained by summarizing the components of the dipoles in the direction of external magnetic field:

$$M = \frac{1}{V}\sum_{i=1}^{N} \boldsymbol{m}_i \frac{\boldsymbol{H}_0}{|\boldsymbol{H}_0|} \tag{25}$$

Our results on Fig. 6 have been presented at 2-2 different values of densities and dipole moments. The effective field based on (24) and the magnetization as well are depicted in function of external magnetic field. In contrast with Fig. 1 and 2 the simulation and theoretical results show good agreement. In case of former theories the most striking differences were experienced at the „elbow", around $H_0^* \approx 1$. By applying tanh function in (18) and (20) this problem was handled.

DOI: 10.14232/analecta.2018.2.1-12

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REVIEW OF FACULTY OF ENGINEERING
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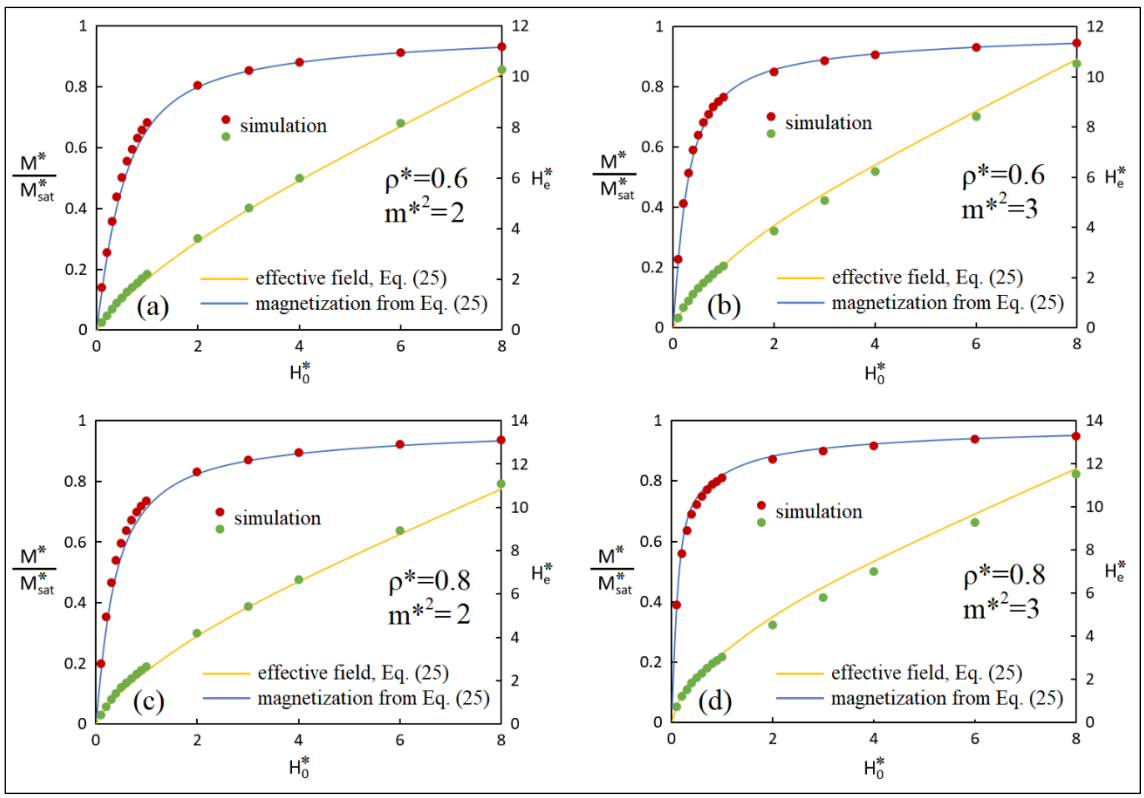

Figure 6. The values of magnetization curve (left axis) and effective magnetic field (right axis) in function of external magnetic field according to the present theory (24) comparing to the simulations.

According to Tab. 2 and (24) at low density and high external field the present theory is reproduced the results of former theories, because the values of H_e' are zero. Similarly according to Tab. 1 and (24) at low density and low external field the present theory is reproduced the results of former theories, because the values of p converge to zero. It can be said that our theory works well up to $\rho^* = 0.85$. Our study has shown perfectly the delusion that the magnetism can be handled theoretically jointly at low and high external field. At low external field the chains are not parallal to this external field, but they can be handled as macroparticles [10]. While at high external field the chains are more or less parallel to the external field, thus the magnetization is determined by the orientation of individual particles forming these chains.

DOI: 10.14232/analecta.2018.2.1-12

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REVIEW OF FACULTY OF ENGINEERING
Analecta Technica Szegedinensia
ISSN 2064-7964

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4. CONCLUSION

In this paper a new magnetization formula has been introduced for dense aggregated dipolar hard sphere fluids. At low external magnetic field the expression of susceptibility [10] has been used, while at high external field the reduction of effective magnetic field has been led to good results. The merging of these two theories was done with the help of tanh function. It is importand to emphasize that the final formula (24) does not contain empirical elements. The calculation of p chaining probability variable was done numerically [10], but not by fitting. The reduction of effective field was justified mathematically, because as the Fig. 3 shows in certain cases the $H_e(H_0)$ function is divalent, furthermore the particles in the chains are not fixed, but are swinging. The calculation of this reduction was also numerical (15). As shown in Fig. 6 our theory works well at high density and dipole moment as well.

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DOI: 10.14232/analecta.2018.2.1-12

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REVIEW OF FACULTY OF ENGINEERING
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ISSN 2064-7964

Vol. 12, No. 2 **2018**

THE ANAEROBIC DIGESTION OF SHEEP MANURE IN SELF-DESIGNED LOW-COST BIOGAS REACTOR

Gábor Nagy, Alexandra Takács, András Arnold Kállay, Dóra Mentes
[1]Department of Combustion Technology and Thermal Energy, Faculty of Materials Science and Engineering,
University of Miskolc, Hungary
nagy.gabi@uni-miskolc.hu

ABSTRACT

One of the possible utilisation methods for organic wastes is anaerobe decomposition (fermentation). The main product of this process is biogas which is usually used for energy purposes due to its composition (mainly methane and carbon dioxide). The residual solid material after fermentation can be used as soil conditioner.
Lab-scale fermentation can be carried out using the "VDI 4630 – Fermentation of organic materials Characterisation of the substrate, sampling, collection of material data, fermentation tests" standard. Based on the conditions described in the standard, a small-scale low-budget reactor system were prepared. The temperature during the holding time was controlled with water bath and the gas production was determined with fluid displacement method. A peristaltic pump was used for the recirculation of the gas to mix the base material. Furthermore, the temperatures of the environment, the water baths and the inside of each reactor was automatically registered on a data collector.
Based on the gathered data, the system is applicable for biogas production from sheep manure. The produced biogas quantities were between 0.01-0.15 m^3/kg TS and the methane content was 24-63 vol% during the experiment at various temperatures, using different inoculants.

Keywords: biogas reactor, fermentation, sheep manure, slurry

1. INTRODUCTION

The natural degradation of organic material by microorganisms under anaerobic conditions results in the production of biogas. During anaerobic digestion, organic material is converted into biogas, a renewable fuel. Biogas, due to its high CH_4 content, could be used to produce electricity, heat or vehicle fuel. Recently, the anaerobic digestion of agricultural and industrial wastes, municipal organic waste, sewage sludge, etc. has become a commonly used method for renewable energy production. The volume yield of Biogas production is affected by several factors, not only the origin and composition of the base material, but the temperature variation, pH and concentration of total solid and total organic etc. can have significant effect on the quantity and quality of the produced gas [1, 2].
Temperature is one of the key factors, as three kinds of microorganisms can be distinguished based on the temperature intervals they can produce biogas [3]. As a result, the applied technology can be operated in three temperature intervals as well: psychrophilic (environmental temperature), mesophilic (optimally 32-42 °C) and thermophilic (<50 °C) [3]. As the temperature is increased, the gas yield per time unit is expected to increase and the time of the process to decrease. However, higher reactor temperature means additional costs. Generally, wet technology is used for biogas production, during which the maximum dry matter content of the used material is 15% [4]. Using such dry matter content, the base material is still easy to mix and pump. The gas production capability of the base materials can be examined under laboratory conditions using the standard "*VDI 4630 – Fermentation of organic materials Characterisation of the substrate, sampling, collection of material data, fermentation tests*". According to the standard, a climatic chamber or temperature-regulated water bath is necessary to keep the anaerobic digesters at a constant temperature.
The aim of the experiments was to develop a low-budget biogas reactor that based on this standard, and the application of a water bath was chosen. The system, beside meeting the criteria in the standard, can mix the base material and record the temperatures. It is capable of parallelly operating reactors at various water

DOI: 10.14232/analecta.2018.2.13-23

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REVIEW OF FACULTY OF ENGINEERING
Analecta Technica Szegedinensia
ISSN 2064-7964
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bath temperatures. For the tests, environmental temperature (psychrophilic conditions), 34 °C (mesophilic conditions) and 50 °C (thermophilic conditions) were used.
Sheep manure was used to test the system, which is a low-quality base material, according to literature [5]. The gas yield was around 0.1-0.4 m^3/kg dry base material [6, 7, 8], the methane content of the produced gas was expected to be 40-65 vol% [7, 9, 10, 11, 12]. Thus, the biogas should be applicable for energy purposes.

2. MATERIALS AND METHODS

2.1. Materials

The digester system vas tested using sheep manure. The dry matter content (TS) was decreased to 18 wt.% for better mixing and homogeneity. During the experiments, 0, 10 and 20 wt.% digested cow manure (DCM) was added as inoculant. The properties of the base material are summarised in Tab. 1.

Table 1. Ultimate and proximate analysis of the base material

	In relation to the dry matter							In relation to the feed material	
	Nitrogen	Carbon	Hydrogen	Sulphur	Oxygen	Ash	HHV	Moisture	pH
	wt%						MJ/kg	wt%	-
Sheep manure	2.59	29.28	3.85	0.70	17.17	46.42	9.87	15.1	7.68
Digested cow manure (DCM)	2.25	37.70	5.27	0.71	20.07	33.00	11.30	79.2	8.81

2.2. Fermentation setup

The three main parts of the developed system are the temperature-regulated water bath to keep the reactors at the examined temperature intervals, the anaerobic digester system for biogas production the and the data logger to continuously monitor the temperatures at various parts of the system.
The temperature-regulated water bath system can be observed in Fig. 1. The temperature of the water bath is controlled by a W1209 digital thermostat (Fig. 1/1). To reach the 34 °C water temperature, an Atman 100 W aquarium heater was used, but a 600 W immersion heater was necessary to achieve 50 °C water temperature (Fig. 1/2). The water for the bath (Fig. 1/3) was held in a 40 litres polypropylene harvest crate (Fig. 1/4). To monitor the temperature of the bath, an NTC temperature sensor was added (Fig. 1/5) to the system which was directly connected to the heater. The circulation of the water bath was achieved with an aquarium pump with 300 l/h performance (Fig. 1/6). Due to the evaporation of the water bath, approximately 1-2 litres per day water should be replenished. When the water level was low according to the liquid level sensor (Fig. 1/7), the liquid level controller (Fig. 1/8) proceeded the automatic water replenishment from a container (Fig. 1/9) using a 240 l/h performance submersible pump (Fig. 1/10). To minimise the rate of evaporation from the 50 °C warm water, polystyrene sheets were put on the surface of the water.

DOI: 10.14232/analecta.2018.2.13-23

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REVIEW OF FACULTY OF ENGINEERING
Analecta Technica Szegedinensia
ISSN 2064-7964

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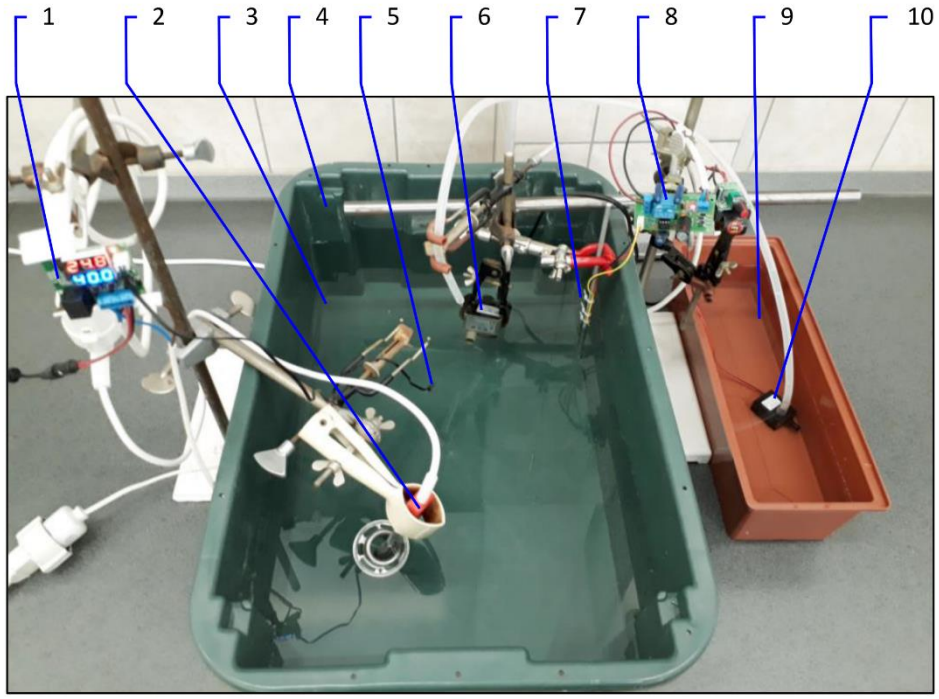

Figure 1. The temperature-regulated water bath system (1 – W1209 digital thermostat; 2 – immersion heater; 3 – water bath; 4 – PP harvest crate; 5 – NTC waterproof temperature sensor; 6 – aquarium pump; 7 – liquid level sensor; 8 – liquid level controller; 9 – replenisher for the water bath; 10 – submersible water pump)

The anaerobic digestion was carried out with and without mixing the base material. The anaerobic digester system equipped with mixer can be found in Fig. 2. In this case, a motor speed controller (Fig. 2/1) is used regulate the speed of the peristatic pump (Fig. 2/2) which is connecter to the reactor with two silicone tubes. With the help of the pump, biogas from the headspace can be mixed to the bottom of the slurry, providing homogeneity and the liberation of the gas from the slurry. If no mixer is used, the abovementioned parts are not included in the system. In both cases, the system can be flushed with inert gas before the digester is started using the flushing tube (Fig. 2/3). Brown glass bottles (Fig. 2/4) which can hold up to approximately 1 kg base material were used as reactors. Thus, the microorganisms were not exposed to light. The anaerobic digesters operate on the principle of fluid displacement: the produced gas leaves the reactor through a tube (Fig. 2/5) and displaces an amount of confining liquid through the overflow (Fig. 2/9) from the container (Fig. 2/10) equal to the volume of the gas. 1.5 l soft drink bottles were used as confining liquid containers, filled with 6M NaCl solution.

The quantity of the produced gas can be measured daily by reading off the amount of displaced liquid. Then, the container can be refilled with confining liquid from a 50 ml syringe barrel (Fig. 2/6) without air entering the system using the 3-way stopcock (Fig. 2/7). For this, the overflow should be closed off and the flow from the barrel opened with the stopcock. Then, the directional control valve (Fig. 2/8) can be used at the end of the flushing tube to let the liquid from the barrel enter the container. As the level of the liquid starts increasing in the container, some of the gas is transferred through the flushing tube. At this point, samples can be taken for further analyses.

DOI: 10.14232/analecta.2018.2.13-23

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ISSN 2064-7964

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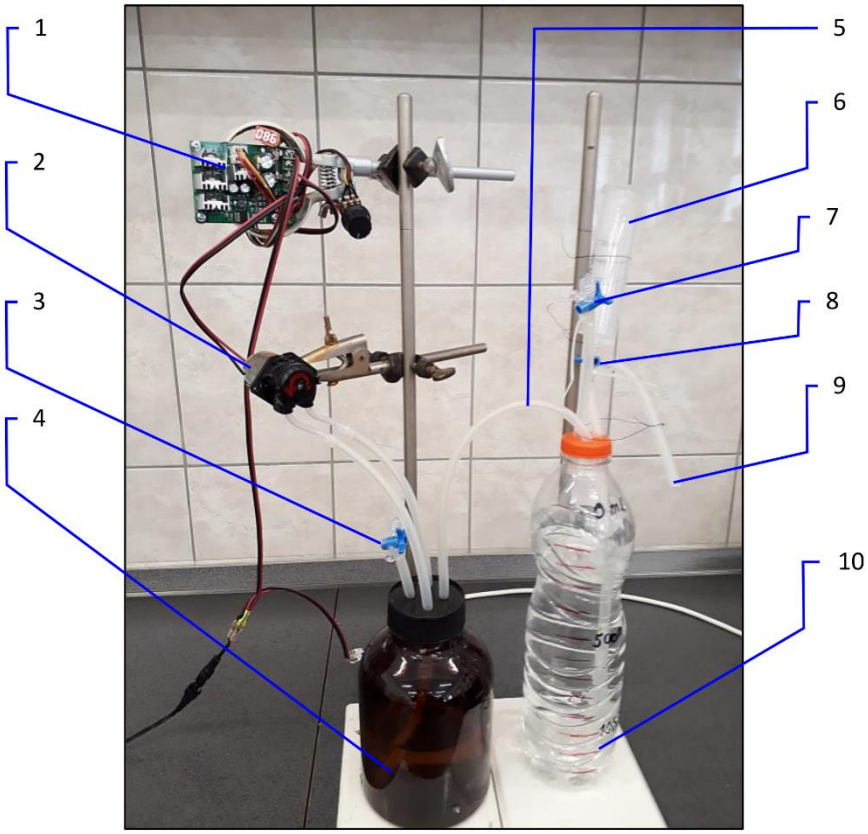

Figure 2. The anaerobic digester system equipped with mixer (1 – motor speed controller; 2 – 12V DC motor with peristaltic pump; 3 – flushing tube with stopcock; 4 – reactor; 5 – tube for biogas departure; 6 – a barrel of a 50 ml syringe to refill the confining liquid container; 7 – flushing tube with a stopcock; 8 – directional control valve; 9 – confining liquid overflow; 10 – confining liquid container)

The temperature can be measured at several places in the prepared system which are registered in a data logger (Fig. 3).

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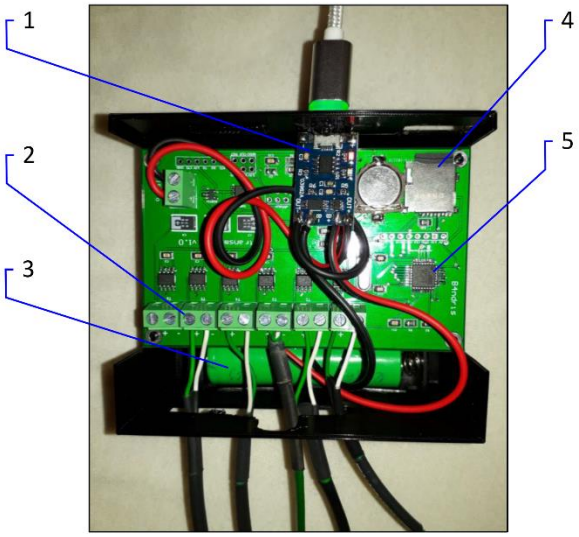

Figure 3. Temperature data logger (1 – battery charger; 2 – connectors of K-type thermocouples; 3 – battery; 4 – microSD card holder; 5 – Atmega328p microchip)

The data logger has been developed at our department for special requirement in different experiments. It consists of an Atmega328p microcontroller and uses special purpose ICs for K-type thermocouple measurements. The data logger also has an RTC (Real Time Clock) IC. Thus, the acquired data stored on the microSD memory card also contains time and date stamps. The data acquisition preferences as data collection interval for example, can be re-programmed to the perquisites of the experiments. The amount of data is only limited by the size of the memory card and it is stored in CSV files. Therefore, it is possible to store several thousands of data points in a 1 MB memory space. The device also contains a rechargeable Li-Ion battery and the ultralow power design provides several months operation on a single charge.
The assembled system can be observed in Fig. 4.

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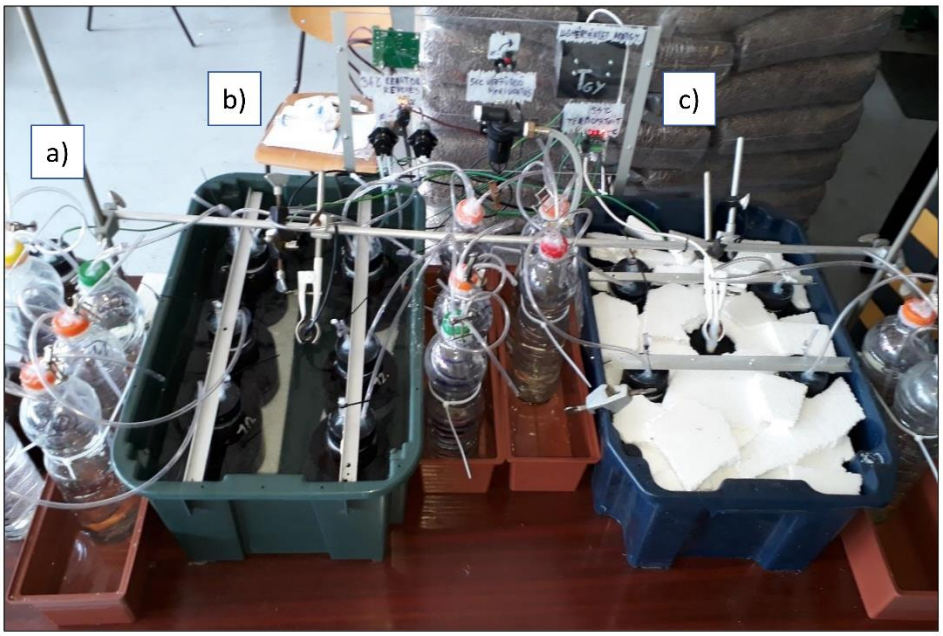

Figure 4. The assembled fermenter system with 2 reactors operating at room temperature (a), 6 at 34 °C (b) and 4 at 50 °C

2.3. Analytical methods

A Mettler Toledo HB43-S moisture analyser equipment was used to determine the moisture content. The ash content was determined by burning the samples at 820 °C to constant weight. Elemental analysis was carried out with a Carlo Erba EA 1108 elemental analyser. The higher heating value (HHV) was examined with a Parr 6200 isoperibolic bomb calorimeter. An Agilent 490 Micro-GC with a COX module was used for the analysis of CH_4, CO_2, CO, C_2 and O_2.

3. RESULTS

The system was tested with 2 reactors operating at room temperature, 6 reactors at 34 °C and 4 reactors at 50 °C. 2 of the reactor operating at 34 °C were equipped with mixers, and the inner temperature of the reactors operating at room temperature was measured with putting thermocouples in the slurries. The inner temperature of the room temperature reactors and the temperature of the room can be seen in Fig. 5, while the temperatures of the 34 and 50 °C warm water bathes are illustrated in Fig. 6.

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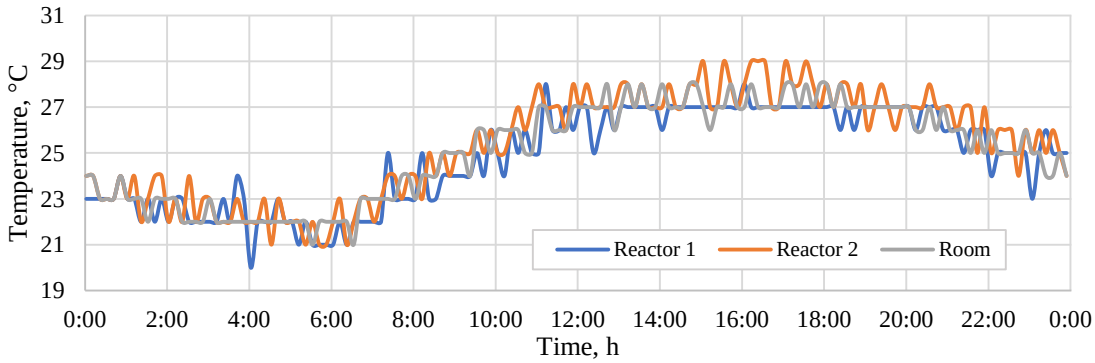

Figure 5. The temperature of the room and the inner temperature of the two room-temperature reactors

Examining the temperatures of the two room-temperature reactors and their environment (Fig. 5) it can be stated that the inner temperatures were often slightly higher than the room. This slightly increased temperature indicates the fermentation process. Fermentation was increased during the day (at higher temperature) than at night.

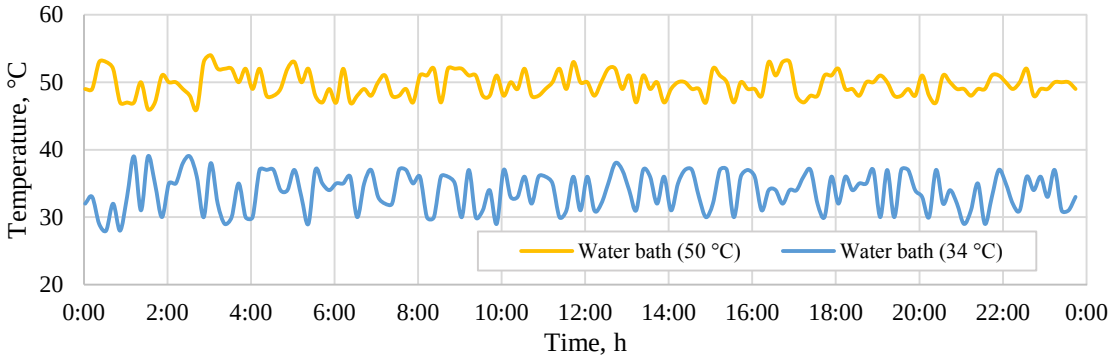

Figure 6. The temperatures of the two water baths

An aquarium heater was used for the 34 °C water bath, which proved to be a cheaper but worse solution than the use of a digital thermostat and immersion heater. The previously set thermostat temperature of 50±0.2 °C resulted in 46-52 °C water temperature, but the aquarium heater which was set to 34 °C only resulted in 28-39 °C water temperature.

The gas yield was registered daily. The gas production expressed in relation to 1 kg base material can be seen in Fig. 7. By increasing the temperature to 34 °C, the gas yield increased but it decreased after further temperature increase. The possible explanation is that the limit temperature of the thermophile zone is 50 °C [13] but the temperature of the water bath was between 46-52 °C (Fig. 6). It can be assumed that this temperature was not optimal for the thermophile bacteria, so the gas yield below the data found in literature [13]. The addition of inoculant had positive effect on the produced gas quantity in all cases.

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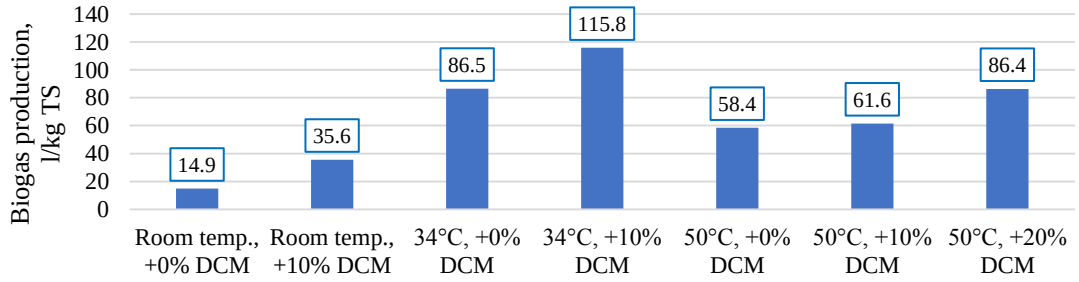

Figure 7. Biogas production

The changes in the examined gas composition during an experiment (34 °C reactor temperature and 10% DCM) can be observed in Fig. 8. In the presented case, the CO_2 content continuously decreased, while the CH_4 content slowly increased till the end of the experiments, when it reached approximately 60 vol%. No H_2 and CO was detectable in the samples. The trend of the gas composition was similar in case of each experiment.

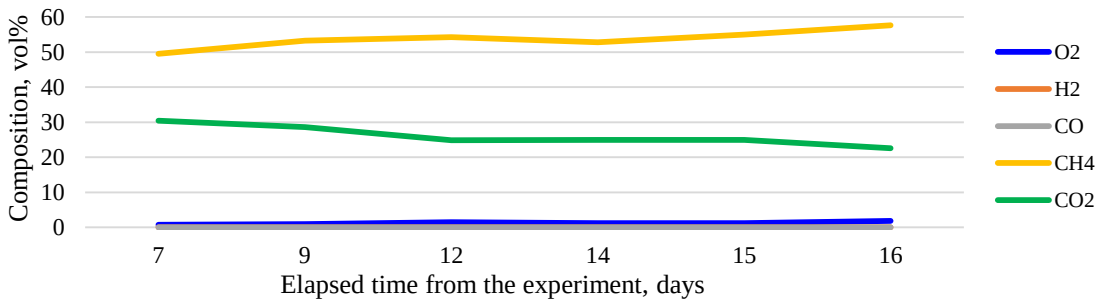

Figure 8. The changes in the examined components of an experiment (34 °C reactor temperature, +10% DCM)

The examination of the maximum methane content of the produced biogas samples (Fig. 9.) revealed that the biogas produced at room temperature without inoculants had the lowest methane content. In comparison, both the temperature increase and the addition of inoculants increased the amount of the most valuable gas component. If no inoculant was added, the highest methane content was achieved at 34 °C.

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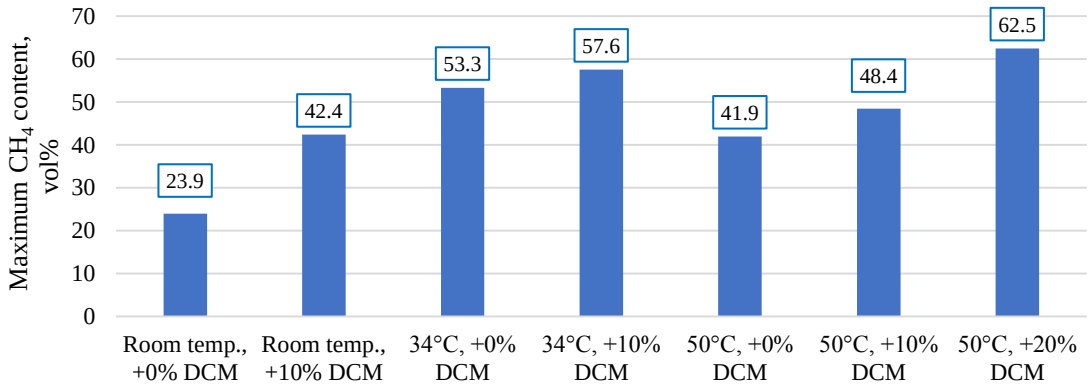

Figure 9. The maximum methane content of the samples

The comparison of the carbon content of the slurry before and after digestion can be observed in Fig. 10 and Fig 11 indicates the decrease of the carbon content of 1 kg base material after the 16-day fermentation. It can be stated that the addition of 10% DCM increased the carbon conversion (gas production), but there was no further increase in case of 20% DCM addition. Moreover, the raw material conversion decreased. The reason for this might be that the digested material had low organic carbon content. Thus, the amount of inoculant was disadvantageous to the reaction.

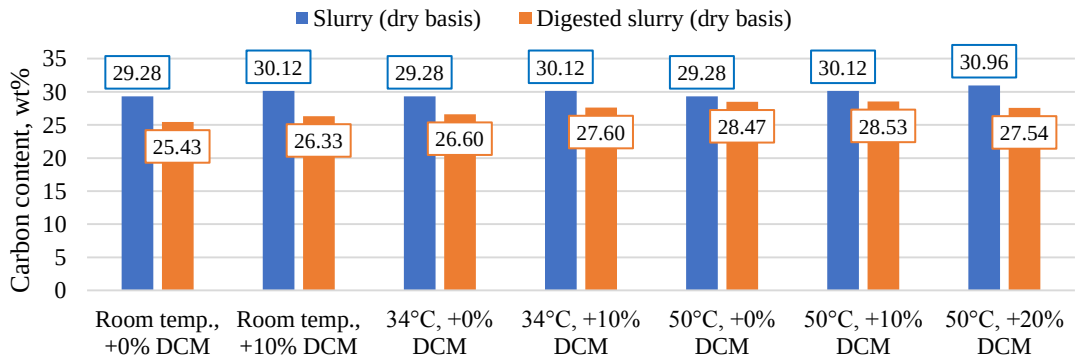

Figure 10. The carbon content of the slurry before and after digestion

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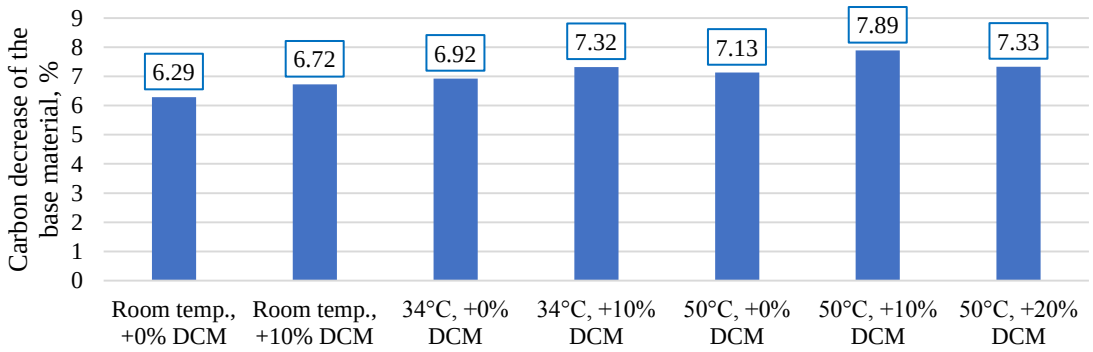

Figure 11. The decrease of the carbon content of 1 kg base material

4. CONCLUSIONS

The developed system was suitable for fermentation experiments. The system is capable to operate at various set temperatures and as mixing is also possible, the effect of the mixing intensity and periodicity can also be examined.
Sheep manure was used to test the system with the addition of cow manure as inoculant. Experiments were carried out at room temperature, 34 and 50 °C. The most gas quantity was produced at 34 °C, and the methane content of the gas was the highest in this case as well (without inoculant and with +10% DCM). The addition of 10% DCM was advantageous on the quantity and quality of the produced gas. However, the use of 20% DCM has lower effect on the decrease of the carbon content of the raw material.

ACKNOWLEDGEMENT

The described article was carried out as part of the EFOP-3.6.1-16-00011 “Younger and Renewing University – Innovative Knowledge City – institutional development of the University of Miskolc aiming at intelligent specialisation” project implemented in the framework of the Szechenyi 2020 program. The realization of this project is supported by the European Union, co-financed by the European Social Fund.

The authors are grateful to Mária Ambrus for her linguistic advice.

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REVIEW OF FACULTY OF ENGINEERING
Analecta Technica Szegedinensia
ISSN 2064-7964

Vol. 12, No. 2 **2018**

THE WAY OF THE PHARMACEUTICAL INGREDIENTS TO THE FINISHED PHARMACEUTICAL FORM

[1]Bence Rafael, [2]Nóra Kuruczleki, [3]József Gál
[1]Faculty of Pharmacy University of Szeged, Szeged, Hungary
[2]Faculty of Economics and Management, University of Szeged, Szeged, Hungary
[3]Faculty of Engineering, University of Szeged, Szeged, Hungary
e-mail: galj@mk.u-szeged.hu

ABSTRACT

The modern pharmaceutical industry is a strictly controlled area. Both national and international rules apply, but none of these deals with logistical issues arising from the manufacture of the product. Following the path of a drug, it is possible to get acquainted with the problems that arise and their solution.
The drug is much more than a common product. The drug is a product of confidence, which is provided with information. It defines its quality as well, to comply with the relevant directives and standards in the manufacture of, and that the enclosed information is sent to the user.
This requires the manufacturer, the distributor and the user to comply with it. There is no production without material handling, but GMP (Good Manufacturing Practice) does not yet have a chapter on logistics. References to handling raw materials and finished products can be found in the corresponding GMP chapters, the responsibility of the correct execution are borne by the manufacturer. In this case, the effect of the common sense prevails exponentially, keep the medicine in mind and it has to be done, that no loss, no quality deterioration is not caused by the transport, handling of such loads, storage.
It is typical that the raw material and the finished product are going through the entire site during the pharmaceutical manufacture. Starting from the warehouse, it runs through the manufacturing facilities, on the packaging, and some units go to the lab, so that eventually, in medicine form returns to the warehouse, from where it goes further in the supply chain through the pharmacies to the patients.
In our study we examine the logistics activity and problems of a small pharmaceutical company and tasks to be solved presented in the light of the theory.

Keywords: pharmacy, logistics, GMP, drug

1. INRODUCTION

The XCV Law of 2005 states in its § 1 about „the modification of laws regulating the pharmaceutical market that „medicine: any material or its mixture which appears as a product to prevent or heal human diseases, or materials and their mixture which are applied in or on the human body in order to establish a medical diagnosis, to restore, improve or modify a physiological function of a man by producing pharmacological, immunological or metabolic effects.” [1]
However, the drug is much more than that. The drug is a product of confidence provided with information. The quality of a medicinal product is determined by whether the guidelines and regulations concerning its production are complied with or whether the provided information gets to the user.
We are not discussing the latter one but our article is giving a survey about what the pharmaceutical ingredient goes through in its manufacturing process in the pharmaceutical factory and what directions

DOI: 10.14232/analecta.2018.2.24-31

Analecta
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regulate these processes. Taking an actual example (without specifying either the company or the product but following the steps of a known technological process), we are describing what logistical tasks a pharmaceutical factory has to face and how they can be solved.

2. THE PHARMACEUTICAL INDUSTRY AND ITS REGULATION

Hungarian pharmaceuticals are subject to many domestic, international and EU regulations. Unsurprisingly, the most important domestic law is the above mentioned 2005 XCV Law which is referred to as Pharmaceutical Law, shortly. The scope of this law covers manufacturing, production and marketing medicines for human use. This law articulates mainly the primary conditions, legal acts and deadlines of the drug delivery chain, whilst regarding drug production, it refers to the valid European directives.
The Good Manufacturing Practice (shortly: GMP) is a continuously updated code issued by the European Committee which is implemented by the Directive 2001/83/EK of the European Parliament and Council [4]. The GMP is a soft law. Something is a soft law when it does not have a clear, generally accepted concept in a legal sense: or just taking it simply, it is „unclear".
The GMP is exactly like this: a guideline which describes what should be taken in account when producing a medicinal product to achieve and to assure the necessary quality but it does not include how it should be done exactly. It can be seen from the fact that how often we can find expressions like „suitable" and „adequate" in the guideline – but it is up to everyone to decide what is right for them. The directives of GMP have to be applied for the given manufacturing site in compliance with the law and the common sense.

3. THE IMPORTANCE OF DOCUMENTATION

Chapter 4 of the Good Manufacturing Practice is about documentation. Everybody must know the expressions like *Standard Operational Regulations* (or SOR) or *Work instructions* (or WI). Nowadays, the process control is well-regulated not only in the industry but also in branches with a developed quality assurance, like public health, trade or anything else. The SOR or the WI materialize the directives of GMP, since we can employ them to project the directives to the given manufacturing site or the given situation. [3]
In addition to the exact task fulfilment, it has another important function. Concerning pharmaceutical production, documentation makes tracking the product possible, whether it is within the manufacturing area (is it inside the sluice or has it been taken to the storage?) or what the condition of the product is (has the ointment been filled in the tubes or is it still in the ointment manufacturing equipment?).
It has a significant part in the pharmaceutical factory that drugs and pharmaceutical basic materials cannot go on without any written „permission". What chaos would it cause if a group leader just sitting on the forklift took 200 kg of yellow vaseline to produce ointment without giving any filled form or without saying it to the store-keeper! The given basic material might as well be taken to the right place but it also can happen that everybody would seek for it since it has not been documented. The right documentation tracks the path of the medicinal product from the warehouse through the production line to making it into a final product, thus it helps the manufacturers'work and it is an organic part of the quality assurance system.

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4. QUESTIONS RELATED TO GMP CHAPTERS

As I have mentioned above, the GMP is a *soft* law, its content can be widely interpreted, and there can be more solutions at the same time to comply with the GMP requirements in drug production. Let's look at some examples for what is written in the GMP text and what questions it raises [2]:

1. GMP Chapter 3, PREMISES AND EQUIPMENTS

The order of interconnection of rooms has to be designed so that it can follow the logical order of the production operation, and the required level of hygiene can be reached by them.

The logical order of drug production is the following: the basic materials have to be measured with suitable scales into the proper production equipment (measuring room), the right form of the drug has to be created (operation room), the finished form of the drug has to be provided with the primary (packing room) and then with the secondary wrapping (cardboarding room), and finally, the finished product has to be taken to the storehouse.

Let's imagine a pharmaceutical factory. If we followed the above-mentioned logical order, it would be sensible if the rooms, which are suitable for the particular processes, followed each other closely. In reality, it cannot be accomplished very often because there is not enough place or not only one type of drug is produced in the given building.

It can also happen that after a renovation the order of rooms has been changed but not to such extent that it would hinder the process of drug production: the measuring room will always be before the operation and packing rooms, it would be nonsense if it were between them and the semi-finished should be taken back and forth between these rooms.

2. GMP Chapter 3, PREMISES AND EQUIPMENTS, par. 3.8

The work space and inter-production storage area are considered to be good if the equipment and materials can be arranged in an orderly and logical way, minimizing the risk of mixing different medicines or their constituent substances.

The guideline requires only the order but it does not prescribe how the stock should be stored eg. in the storehouse. Should it be a mixed storehouse or a separate storage for the basic materials and the finished products? Should we order the raw materials in alphabetical order or according to the drug they are used in? Or by the storing units (barrels on the ground on pallets, bags and boxes on the shelves)? To decide on these questions it is necessary to know the conditions of the particular manufacturing plants.

3. GMP Chapter 5, PRODUCTION, par. 5.11.

If working with dry substances or products, take all precautions to prevent dust formation and scattering.

We can prevent dust formation and scattering with several technologies which are well-known for pharmaceutical experts. The regulation makes application of any accepted method possible for us depending on which one is the most suitable.

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5. GMP AND LOGISTICS

There is no production without transportation, still the GMP does not have a chapter on logistics. References concerning management of raw materials and finished products are hidden in the GMP chapters, it is the manufacturer who takes the responsibility for the proper implementation. In this case, the common sense has even more emphasis, we have to have the protection of drugs in sight and to act so that transportation cannot cause any loss or damage in quality.

6. CASE STUDY

When examining the activity of a pharmaceutical factory, not only production but quality control should be considered, as well. It is natural that you have to know the technological steps of drug production and the critical phases well, otherwise you would not be able to see in the quality control laboratory what causes deteriorations in quality. Our article does not deal with quality control and quality assurance, so we are not summing up the steps of drug production from the view of the daily routine but from a logistical aspect, and we are aiming at discovering what problems can emerge in the logistics within the production area. We are not specifying the pharmaceutical company, the actual product and its active agents, it is sufficient to know that we are following the production of an ointment of multi-active agents.

The production begins with the purchase of the active and additional ingredients. We purchase all the basic materials from certified and approved suppliers and always from the same place. We give a new identification number (number and date, in a particular format) and a yellow „Under examination" label to the incoming basic materials in the storehouse. This yellow label stays there until sampling is done and the quality control laboratory qualifies the basic material.

Sampling from the basic material is done in the sampling room. On the site of the company in question the sampling room is located inside the warehouse and its material entrance opens from the side of the sluice leading to the courtyard. And this raises the first logistical problem. At present, the practice is that the incoming materials cannot enter the storehouse without a green label, until they are stored in the area located between the sluice and the storing place. When a lot of basic materials come all in once, it causes a very unpleasant situation since it hinders the free material traffic. Now, the only solution for it is that the lab works very fast, they qualify the basic material within a day, and then it can go on to the storehouse.

The storehouse of the firm is a mixed one: basic and wrapping materials, drugs and dietary supplements are stored in one place. As a rule, only one unit of a product can be located on one pallet. However, it can happen that the packaging unit of the basic material is very small, and a whole pallet cannot be wasted on it. This problem is solved so that more items are placed in one pallet but strictly separated in order to prevent mixing.

DOI: 10.14232/analecta.2018.2.24-31

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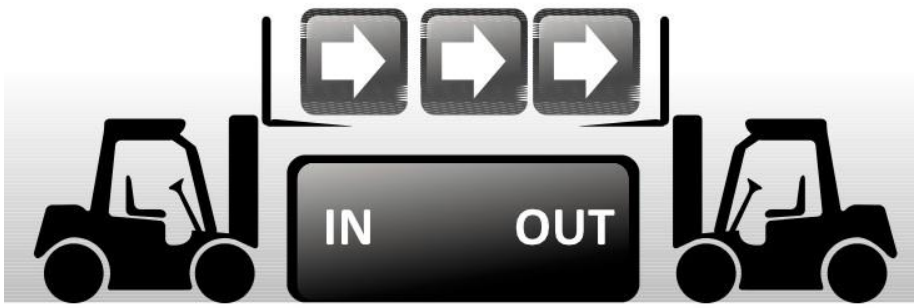

Figure 1. The FIFO-principle (Source: https://image.slidesharecdn.com/ 23.09.2018.)

The basic materials are taken from the storehouse on the basis of the FIFO-principle. Here, they can be tracked very easily because both basic and wrapping materials are given numbers, which makes clear that the basic material identified with a number beginning with 1992 arrived earlier than the one with 2008.
The basic materials are transported in their original wrappings on pallets with forklifts through the site to the right building. The layout of building „A" is not fully convenient: it is an old building constructed well before the GMP directives, in the 20th century, so that is why there is a corridor for the personnel wedged in between the sluice for the materials, which leads to the production area, and the courtyard. Also, because of this layout even the forklift cannot enter the building. This arrangement would make production more difficult since it would prevent moving the basic materials for the ointment in large masses, that is why it is necessary to implement two changes:

- measuring the oily basic materials of the ointment into the production equipment should not be done - the oily materials of the ointment is not measured in the production equipment in solid form, but after melting them, the liquids are pumped into the ointment production equipment (note: in big pharmaceutical factories the melted ointment flows in pipelines during the whole process of production, but in this case, being a small firm, there is no opportunity to use dedicated pipes). The barrels, which contain the solid vaseline, wax, etc., are not to be taken into the production area, the door of the melting room opens to the courtyard, so it can be easily accessable with forklifts, while the basic material of the ointment does not contact the outside world, since it gets melted with heating belts without removing the top of the barrels. The tube of the pump is placed into the barrel through a small hole, thus the basic material can be pumped from the barrel in a clean and accurate way.
- Neither other basic materials of smaller quantity can be taken directly near the production area with forklifts. These are moved to the sluice for the material manually or with „frogs" where they get cleaned and then, taken to the production area.

The order of rooms in the production area corresponds to the logical order. The room for ointment production is located right next to the measuring room. The solid basic materials are measured on proper scales into plastic sacks, then in case of production of more items they are placed into separate packing-cases according to the production numbers of the ointment. The building „A" has been designed to

DOI: 10.14232/analecta.2018.2.24-31

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manufacture ointment, solutions and sterile formulations, too. Each production area has a measuring room, so it is not necessary to move the measured materials all over the building. Building "B", on the other hand, has been designed for manufacturing solid formulations, but only with one measurer. The reason for it is that there is no parallel production here, while in building „A" ointment, solution and sterile drug can be manufactured at the same time.

The composition is a solution-suspension-type ointment, so there are several complex technological steps to prepare it. The suspension and the solution are made in separate utensils, and only after that they are mixed in the equipment of ointment production. As the size of a lot (batch) is not large, weighing only 150 kgs, so preparation and moving the suspension and alcoholic solution containing two active agents each cannot challenge logistics. None of them weighs more than 10 kgs, so even one single person can take it manually to the equipment of ointment production.

The prepared „*lose*" ointment is filled into tubes with another equipment. We think that this process is completed, though not irregularly, in an improper way at the company. At present, it is done so that tilting the ointment producing equipment they pour the warm ointment into vessels, and then it is poured again into the feed tank of the equipment for filling ointment. It is a hard process and needs continuous attention, but there is a solution: in larger pharmaceutical factories the finished ointment is transported to the filling machine in a pipeline. Here, it is impossible to implement it because of the size of the items.

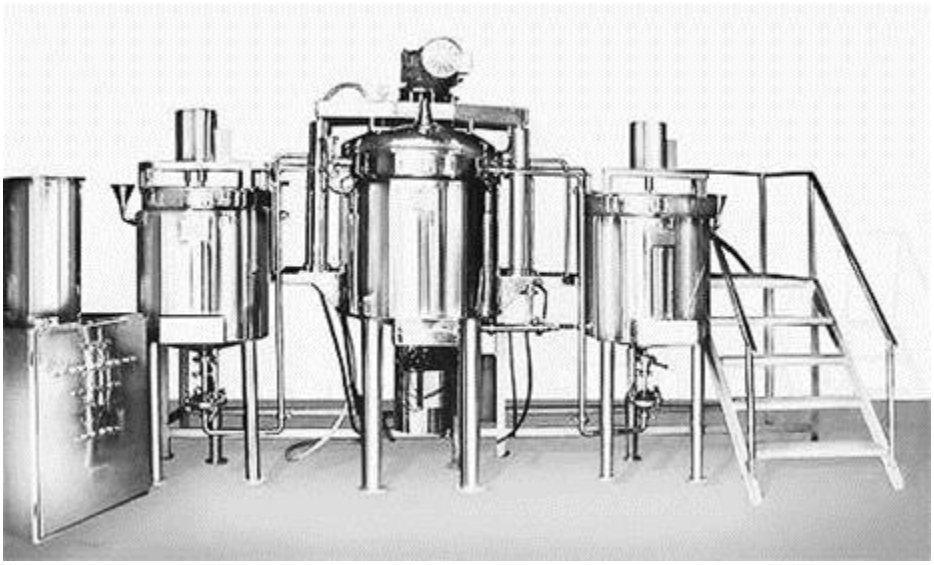

Figure 2. Industrial ointment producing equipment (Source: The Basics of Pharmaceutical Technology, Dévay A. (2013.) [5])

The ointments, then, are put into so-called akylux tubes of small size, containing around 7.500 tubes, which are transported on pallets to the storehouse with forklifts. The cardboarding room, where the drugs are

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provided with information for the sick, is located inside the storehouse opening from the area behind the sluice where the basic material arrives. As we have mentioned above, it often happens that the basic materials occupy all the place making it impossible to accept new pallets. This problem is resolved improperly because the finished ointment stays in the production area, in the sluice. It does not really comply with the regulations but it can happen. Sampling for quality control can be done here, too.
The finished ointment wrapped in cardboards and provided with information leaflet is taken to the storehouse where they are placed so that the FIFO-principle can prevail. The item manufactured the earliest from each product is placed down, and the new ones are put on the shelves above. If each item from a lot has been released from the storehouse, each item of the following lot is placed one shelf down, so that it can be available according to the FIFO-principle.

Figure 3. An example for a well-organised storehouse (ADR Logistics Kft.) (Source: http://www.adr-logistics.hu 23.09.2018.)

7. DOCUMENTATION DURING PRODUCTION

Documentation of the production does not begin with the *Sourcing Material Claimant*, but with the *Sample Record* following the receipt of the raw material. The regulation includes each stage of the production, a detailed *Lot Form* is completed for every single production item. During sales, the appropriate production certificate *Quality Certificate* is provided with the product.

8. SUMMARY

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In pharmaceutical production the basic material and then the finished product moves inside the whole site. Starting from the storehouse it goes through the producing rooms, the cardboarding room, some items go to the laboratory until in the form of a product returns to the storehouse where it is carried on to the sick people in the supply chain. It is typical to this particular company that in general, it complies with the GMP guidelines, though being a small company there can be obstacles (See: the layout of building „A") which they are not able to improve at present.
The drug industry is strictly regulated but due to its variety there can be areas which are not fully covered. Like proper logistics. Resolution of logistical problems depends on the imagination of producers and while they can protect the quality of drugs – together with the sick people- we should not worry about whether we have chosen the right method.

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DOI: 10.14232/analecta.2018.2.24-31

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ISSN 2064-7964

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VIBRATIONAL TESTS AND ANALYSIS ON MATERIALS USED IN AIRCRAFT

Sándor Csikós, Tamás Molnár, Péter Szuchy, László Gogolák, István Bíró, József Sárosi
Department of Technology, Faculty of Engineering, University of Szeged, Mars tér 7. 6724, Szeged, Hungary
e-mail: csikos-s@mk.u-szeged.hu

ABSTRACT

The current cargo capacity for aircraft is about 20% of their total weight, increasing this ratio would significantly increase the economics of aircraft logistics. This is why it's important for material sciences to advance so that the materials used in aircraft construction become lighter while still retaining their structural integrity. In this paper we examined materials used in aircraft construction (steel, aluminum, plastics and composites) at the University of Szeged Faculty of Engineering. Using vibrational analysis we analyzed the test pieces for their natural frequency, we did this to gain insight to the range of frequencies that are least attenuated by the material the aircraft wings are made from. Using the data we gathered we wish to draw conclusions to which materials are more suited for aircraft wing construction.

Keywords: composites, vibrational analysis, material science

1. INTRODUCTION

In this paper we set out on the path to discover the resonant frequencies of materials used in aircraft construction. The motivation was to increase the ratio of cargo weight compared to the aircraft's weight. This would mean a more energy efficient aircraft which in turn could lower future prices for shipping or air travel in general. Vibrational analysis is an important tool in many fields of engineering. It can supply us with information on frequency ranges we should avoid given a certain construct. Also since materials in construction age they are subject to wear which can be detected by vibrational analysis. Vibrational analysis has been used for similar purposes in material science, recently in the field of meta materials, where the structure of the material is modified to suit a specific requirement [1-5]. With the right combination of materials and lattice structure these meta materials can achieve vibration attenuation over a specified range, the range we can define by finding the resonant frequencies of the materials chosen. Materials currently used in aircraft construction are aluminium alloys, steel, titanium alloys, composites.
Aluminium is employed due to its low density (2.7 g/cm^3), hi-strength properties, good thermal and electric conductivity, technological effectiveness and high corrosion resistance. But because aluminium loses its strength in great heat, it is not used on the surface of an aircraft.
Steel is a blend of iron and carbon and can be 3 times stronger and denser than aluminium. It is usually used in the landing gear due to their strength and hardness as well as in the surface of aircrafts due to its high heat resistance.
Titanium and its alloys are generally used in the construction of aircraft due to its overall strength, temperature resistance and high deterioration resistance compared to stainless steel and aluminium. Despite being expensive, titanium is utilized in aircraft construction due to its excellent material properties. It is employed in panel and swivel wing devices, hydraulic systems and other parts.
Composite materials are utilized in the production of aircrafts due to their high tensile strength, resistance to compression, low weight and overall resistance to deterioration. Composite materials are composed by way of a base material and bonding agent that strengthens the material all together. Composite materials

DOI: 10.14232/analecta.2018.2.32-36

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improve fuel economy and performance of the aircraft as well as reduce direct operating costs of aircrafts. The most abundantly used composite material is fibre glass that comprises of glass fibres as the base substance and a resin mesh. The downside of using amalgamated materials, however, include high cost and the fact that immediate repair is needed in case of harm. Avoiding fire is also very important when you use composite materials because the resin used weakens and causes the release of poisonous fumes.

2. MATERIALS AND METHODS

The first step to achieving our goal was to acquire the materials that are commonly used in aircraft construction, to set a baseline we also acquired some materials that are not used in aircraft construction but are readily available and their properties widely documented. We made contacts with the trading companies in Csongrád county where we could procure the structure materials S235, S275, S355 in different thickness. For purchasing technical plastics the Kár-Plaszt 2000 Kft. based in Szeged helped us with plastics produced by them, so we could manufacture the standard test specimens. The aluminium alloys applied in aircraft industry were cut out at the airport of Szeged from the wing structure of a used fixed-wing aircraft (therefore we had got authentic values for the mechanical features), from which the tensile specimens were made (Fig. 1).

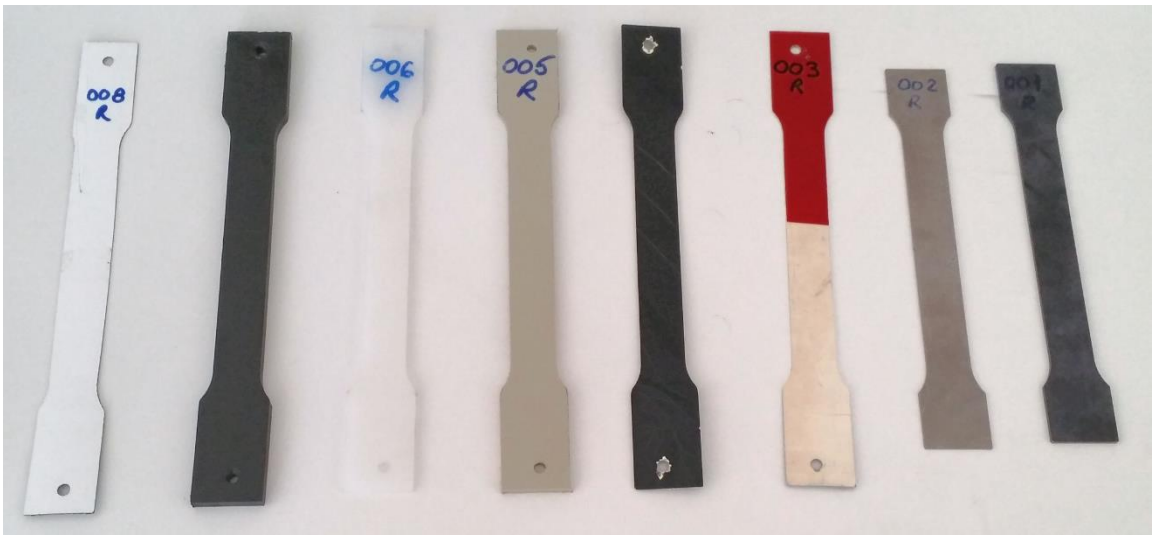

Figure 1. Materials selected to measure resonant frequencies.

Following the acquisition of materials we acquired the software to set frequencies applied to the materials and visualize and evaluate the results. For this purpose we used the RT photon+ software (Fig. 2) device that we will use to generate specific frequencies using the Brüel & Kjaer 892070 LDS VIBRATOR, V201 (Shaker). To drive the shaker we needed a suitable amplifier for this purpose we used the Brüel & Kjaer 4070050-X03 LDS LPA100 - 230V.

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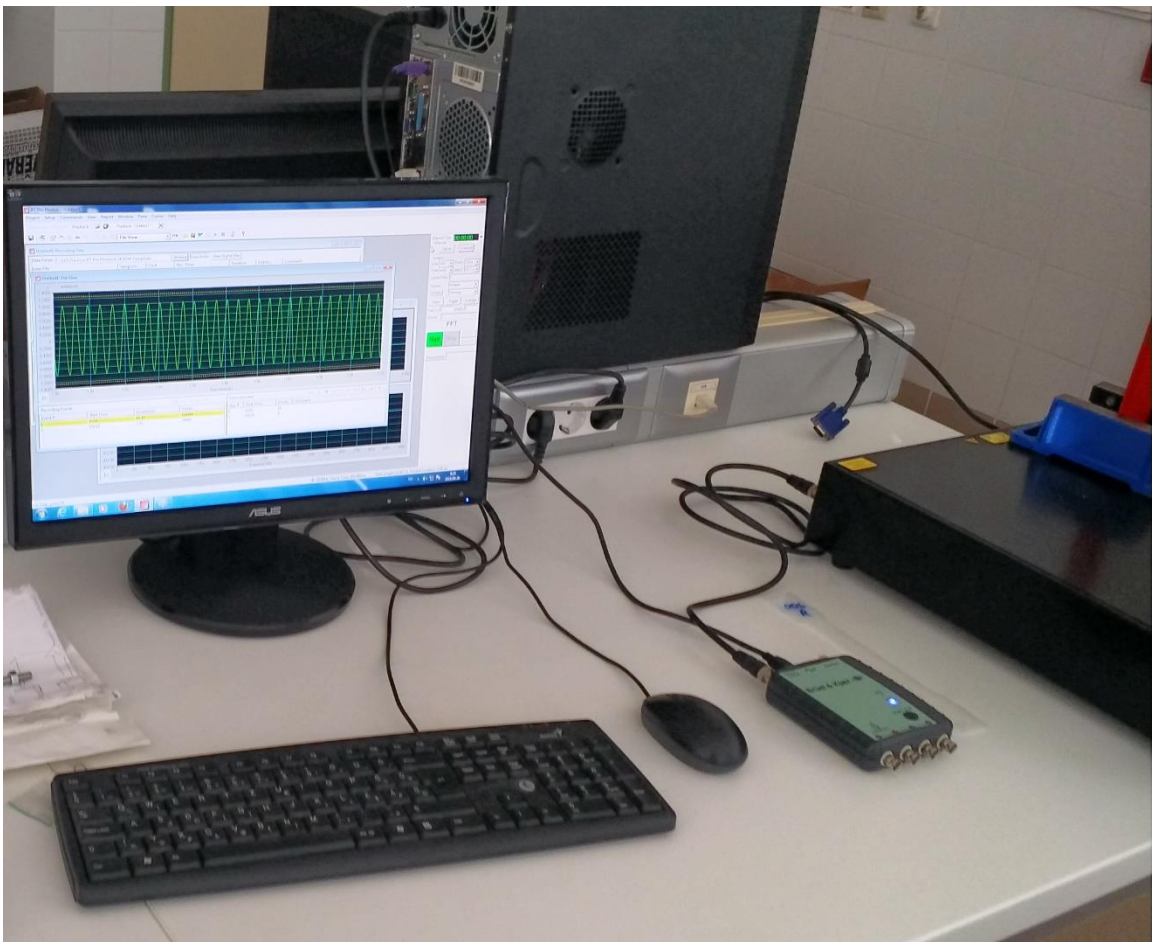

Figure 2. RT photon+ software and DAQ.

Next we designed a test bench on which we will be able to measure the test pieces. The bench consists of a heavy metal frame, a vertically adjustable vice to hold the test pieces and the shaker unit (LDS V201) (Fig 3). The vibration will be measured with accelerometers, one will always be on the shaker giving us feedback of the actual system input and one will be placed on the test piece where we can measure the response of the material to the excitation frequency.

The process of the measurement will take the following steps, we will set the shaker to output white noise with no test piece attached, only the accelerometer. By applying a Fourier transform to this measured signal we will get the bode diagram of the shaker where we can see which frequencies will be attenuated. Since white noise has a uniform frequency spectrum we want to see uniform attenuation on all frequencies, but since this is a physical system such an ideal response is highly unlikely. Some frequencies are bound to be attenuated, according to the handbook of the LDS V201, depending on the mass that the shaker has to excite the frequency range that we can use starts from 80 Hz. Below this the gain is non uniform, to circumvent this and enable the output of a more uniform white noise we will fit a function that will correct the attenuation of the frequencies close to uniform. Following this process we can attach a test piece and

DOI: 10.14232/analecta.2018.2.32-36

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apply the now corrected white noise. As before the accelerometer placed on top of the test piece will provide a response to the excitation signal, where looking for sharp peaks we can see the resonance frequencies.

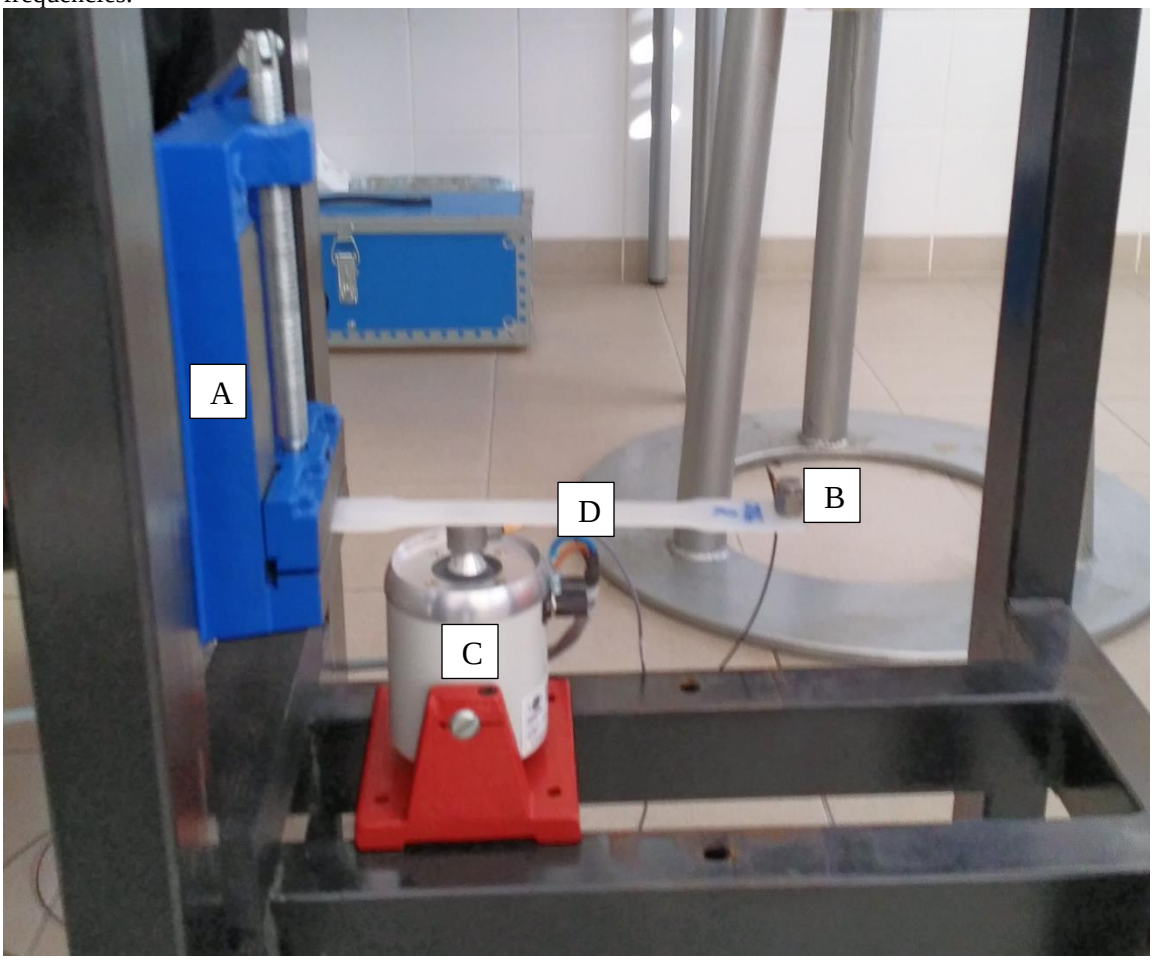

Figure 3. Test bench (A- vice, B- Accelerometer, C- Shaker, D- test piece).

3. RESULTS, DISCUSSION

Once the resonant frequencies are found for each material, the work pieces will be excited at that frequency for a set amount of time. This should create wear in the materials structure. Following this excitation we will perform tensile tests on each of the test pieces. Drawing a baseline with test pieces that were not excited and thus have no wear we can compare the tensile strength of those pieces which were excited for a set period of time. By varying the time these test pieces were excited we can gather more data points, and draw conclusions to which material would be best suited for set objectives.

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4. FUTURE WORK

In future works we hope to draw conclusions to the question which material is most suited for aircraft construction if we want to enhance energy efficiency. Following that we can find out how that materials tensile strength reacts to varying temperatures, also if by using different lattice structures we would get better results than with a solid structure.

ACKNOWLEDGEMENTS

The project has been supported by the European Union, co-financed by the European Social Fund. EFOP-3.6.1-16-2016-00014. Authors are thankful for it.

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DOI: 10.14232/analecta.2018.2.32-36

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ANALYSIS OF THE HUNGARIAN AGRICULTURAL MARKETING – BY THE SUPPLY OF LOCAL PRODUCTS' CONSUMERS

Edina Lendvai, Ágnes Ördög
University of Szeged, Faculty of Engineering, 6724 Szeged Mars tér 7., Hungary
e-mail: lendvai@mk.u-szeged.hu

ABSTRACT

The term agricultural marketing is composed of two words-agriculture and marketing. Agriculture, we can think about the soil, the forests, the sea, so it includes all the primary activities of production systems in relation to animal, plant, food production. But, generally, it is used to mean growing and/or raising crops and livestock. The study of agricultural marketing comprises all the operations, and the agencies conducting them, involved in the movement of farm-produced foods, raw materials and their derivatives, such as textiles, from the farms to the final consumers, and the effects of such operations on farmers, middlemen and consumers.
In our primer research a questionnaire was made by us. The topic of the questionnaire was the consumption of these local products and the knowledge about the common agricultural marketing. The main group of our research was the graduated people, we think, they have more information and income, so they attitude is positive for these products.
We have known, the most of the participants had heard about the agricultural marketing, but the main institute, AMC not yet. The problems with the local products – in the opinion of the participants are: higher price, less choice, no too comfortable shopping.

Keywords: agricultural marketing, questionnaire, local products

1. INTRODUCTION

Nowadays marketing is the basic for all enterprises, it is important and fundamental activity. We can talk about the industry, the service sector or the agriculture. The income of the company is determined by sales of the produced wealth, their methods and their tools. In our days the marketing management has more effective significance, because of the global market and the vigorous competition.
We can talk about marketing, with the help of AMA (American Marketing Association) it is the activity, set of institutions, and processes for creating, communicating, delivering, and exchanging offerings that have value for customers, clients, partners, and society at large[1]. Kotler's definition: Marketing is the social process by which individuals and organizations obtain what they need and want through creating and exchanging value with others [2].
The majority of people in XIXth century worked in agriculture, and after the industrial revolution they went to the service sector. About 3-5 % of employee could supply with food the whole society. Moreover the trade stated to be international and global. The choice of goods has become bigger and bigger, the firms have fought with each other, they want to catch the consumers for themselves. The lifetime of the products has done shorter; the communication and the advertising have turned more intensive. Because of the globalism the far countries has get closer to each other, and their consumption and its structure have interlinked [3].
The term agricultural marketing is composed of two words-agriculture and marketing. Agriculture, we can think about the soil, the forests, the sea, so it includes all the primary activities of production systems in relation to animal, plant, food production. But, generally, it is used to mean growing and/or raising crops and livestock. The study of agricultural marketing, comprises all the operations, and the agencies conducting them, involved in the movement of farm-produced foods, raw materials and their derivatives, such as textiles, from the farms to the final consumers, and the effects of such operations on farmers, middlemen and consumers [4].

DOI: 10.14232/analecta.2018.2.37-44

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According to the National Commission on Agriculture [5] agricultural marketing is a process which starts with a conclusion to produce a profitable farm product, and it contains all the aspects of market structure or method, both functional and institutional, based on technical and economic deliberations, and includes pre- and post-harvest operations.
Meulenberg tried to find the difference between agricultural and simple marketing. He deduced, the agricultural marketing discipline finally will split into agribusiness marketing and agricultural marketing, the prospective lengthening some specific marketing items at the farm level only [6].

The agricultural marketing was developed from the marketing; it covers the raw and the processed food. First it was used in the USA, and people firstly focused to the agricultural products. In the agricultural marketing has spread 4 aspects:
- product (for example meat or milk)
- functional (for example sale)
- organizations (trade units, agents)
- behaviour (between companies and consumers) [7]

Kiruthiga et al have collected the most important things of the agricultural marketing. They has written, that it is very significant, because of the follows [5]:
- Break the vicious circle of poverty
- Optimum utilization of agricultural resources
- Enhance the standard of living
- Basis of employment opportunity
- Basis of industrial development
- Creation of utilization
- Basis of foreign trade
- Source of national revenue
- Create the environment for investment

The FAO study shows the conflict between the agriculture and the industry (table 1). The farmers want the maximum price for their products, but the other participants want low price and maximum quality [8].

Table 1. Conflict of interest in agricultural/food marketing systems
Source: www.fao.org

Key players	Interest
Farmers	Maximum price, unlimited quantities
Manufacturers	Low purchase price, high quality
Traders and retailers	Low purchase price, high quality
Consumers	Low purchase price, high quality

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Since 1970's year, because of the degradation of the increase of the food demand and consumption it has become the unilateral competitor orientation. Only the best companies could be survive the war, so the balanced integrative marketing has spread between the marketing managers. It means, that the successfulness of companies has decided by the adaptation to the macro and micro area [9].

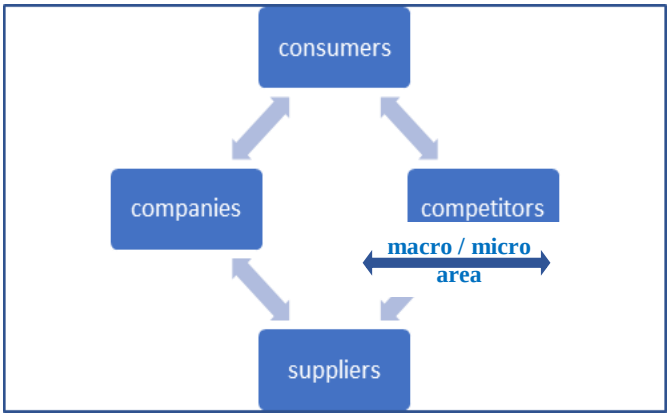

Figure 1. The System of balanced integrative marketing Source [9] (Edited by the authors)

2. MATERIALS AND METHODS

In our primer research a questionnaire was made by us. The topic of the questionnaire was the consumption of these local products and the knowledge about the common agricultural marketing. The main group of our research was the graduated people, we think, they have more information and income, so they attitude is positive for these products. The questionnaire was filled by email (in the KSH (Central Statistical office), the employee of KSH must have be graduated, it was upload to the Facebook, between our acquaintances. Finally the questionnaire was answered by 220 persons – from all part of the country.
The first part of the questionnaire is about the knowledge of the agricultural marketing, the AMC (Agricultural Marketing Centre in Hungary) and its activity, after it we asked people about the local products and the consumer's habit. At the end of the survey we can see the demographic questions. The data analysis and diagrams were made by the Microsoft Office Excel 2010 program.

3. RESULTS AND THEIR EVALUATION

In the Table 2. we can see the most important data about the answerers. As we have written on the chapter "Means and methods", the selected people were the graduated persons, but of course a few has not got. The distribution of the other criterion is multifarious.

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Table 2. The most important parameters of the answerers (N=220)

Parameters	person	%
Gender		
male	55	*25*
female	165	*75*
Age (years)		
under 18	0	*0*
18-35	81	*36,8*
36-55	116	*52,7*
more, than 55	23	*10,5*
Education		
basic	0	*0*
intermediate	53	*24,1*
graduated	167	*75,9*
The type of the living place		
Capital	14	*6,4*
County- centre	125	*56,8*
city	51	*23,2*
village	29	*13,2*
farm	1	*0,5*

The first question was about the meaning the agricultural marketing. We gave 3 answers, descriptions about it. Most people (86.8%) have chosen this sentence: the common agricultural marketing means cooperation, its goal is getting closer the farmers and the consumers, and flowing of the information about the market.

Next multiply choice question is about the known types of agricultural marketing. The answers are on the Figure 2. As we can see most of them have met local market, or any fairs. They visited other events, for example, festivals, or have seen advertisements (Buy Hungarian products – Protect Hungarian products[1]). Only 9 people said, they had never met agricultural marketing.

[1] *In Hungarian language it is a word-joke, too: "Vedd a magyart, védd a magyart!"*

DOI: 10.14232/analecta.2018.2.37-44

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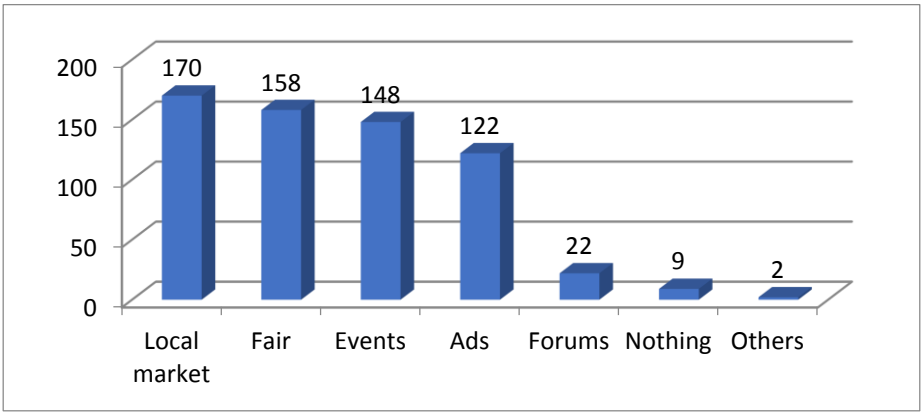

Figure 2. The experiences of the consumers about the agricultural marketing (person, N=220)

In Hungary, the official organization of the agricultural marketing is the Agricultural Marketing Centre (AMC[2]). Maybe it is not too surprising, that the overage Hungarian person has never heard the name. In our research the result is same: 60,9% told this fact. So we hope that our survey will get better known this institute. There are some questions about the most important events of AMC, they are the OMÉK, and the Farmerexpo. The answerers could say their opinion about the happenings, they told, it was "good" (3-93 – 4-19 average points). They were informed about these programs by the Internet, the friends and the social media. The last question about this topic was the future, if they plan to visit the AMC- events. Most of the people say *maybe* (53%), 30% said yes, and the rest don not want to go to the similar proceedings.

In our next question we ask people about the other programmes were organized not by the AMC. 83.2% of them went to some events, usually festivals, for example wine, paprika, mangalitza / curly hair hog, Hungarian Great Plain Animal Husbandry and Agricultural Days (in Hódmezővásárhely). We can say these programs are the part of the national agricultural marketing; however it is not organized by the AMC. The importance is enough, because- as we can see – more people know these events, than the mentioned earlier. Answerers were informed by similar method, like the AMC programs: internet, social media, advertisements, and friends.
More, than half of our group plans to go back to the happenings, festivals, only 2% said, that it is probably not.
After the questions of agricultural marketing and AMC, we turned to the buying habits about local products. 86.8% of 220 survey respondents said yes, they have ever bought a local product. It means our sample-number has changed to 189. Most of them purchased food (40%), home-made goods /artisanal products are on the 2nd place (22%) and those follows the processed food (16%). Some people marked the alcohol and the cosmetics, but it seems, the food products, especially raw foods are the winner (figure 3).

[2] *Agrármarketing Centrum*

DOI: 10.14232/analecta.2018.2.37-44

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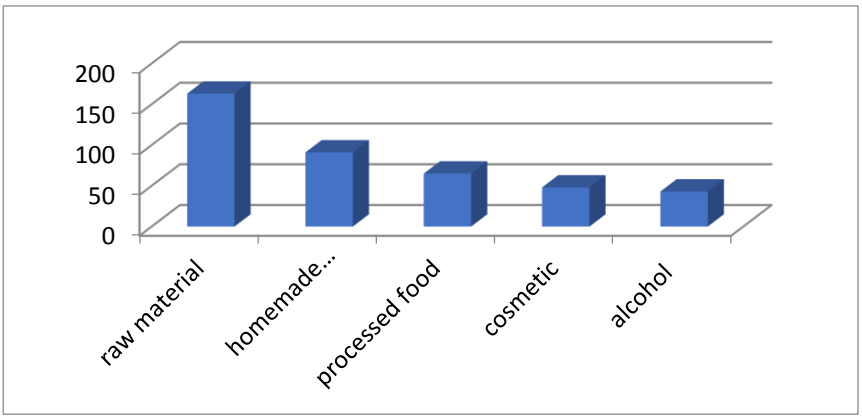

Figure 3. Distribution of the types of the products- purchased by the responders. (N=189)

We try to know, what the most important motivations of the shopping are. We gave 9 aspects, they are:

- it is made from local raw
- quality
- less price
- healthy lifestyle
- bioproducts
- knowing the farmer / producer
- sustainability
- direct connection with the farmer / producer
- strengthen local economy

Everybody could give point (from 1 to 5) to indicate their opinion. Table 3 summarizes the results. We clearly can see, the quality is the most important motivation, because our respondents gave the highest points for this possibility. It means, they can believe in these products. There are two motivations upper than 4 points, the using of local raw material and the healthy lifestyle. Less important role is the bioproducts, the farmer- knowing, the less-price and the sustainability.

DOI: 10.14232/analecta.2018.2.37-44

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Table 3. The average points of the reason, because somebody buy local product (N=189)

Aspect	average point
it is made from local raw	4,13
quality	4,58
less price	3,55
healthy lifestyle	4,10
bioproducts	2,71
knowing the farmer / producer	3,41
sustainability	3,55
direct connection with the farmer / producer	3,51
strengthen local economy	3,97

After the motivation we asked people, tell us about their disappointment, connected with local products. 82 % of them have never felt it, it is a good result. The rest people mentioned the not too god quality and the high price of the product. But, some of them noticed, they had bought the product from the trader and not the producer / farmer. There is a little contradiction, because in the motivation the fewer prices appear at the end, but now persons noticed higher price.
In the last question, when we ask everybody, we want to know the opinion of the answerers, are there any problems associated to the purchasing local products. We gave some key factors:

- food quality risk,
- higher price,
- less choice,
- no too comfortable shopping,
- extensive duration for purchasing,
- seasonality,

and of course was the "other" and the "no problems" possibility too. The results we can see on Figure 4.

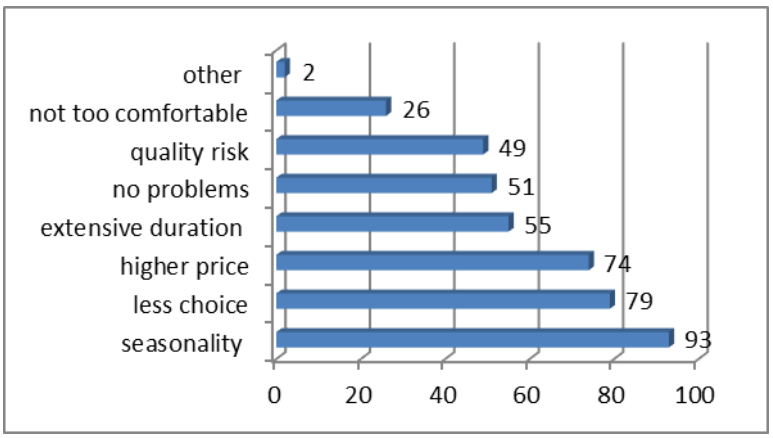

Figure 4. The distribution of the problems – by the survey participants. (Person, N= 220)

DOI: 10.14232/analecta.2018.2.37-44

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Most of them perceived the seasonality and – because of it – the less choice. Really, in supermarkets we can buy always everything. They mentioned the higher price (because of the individuality and more hand-work), extensive duration of the shopping (we cannot buy in the same place), and, sometimes the quality risk. Our opinion, it is happens products in the field industrial, too. About 25 % didn't sense any problems.

4. CONCLUSION

In our survey we tried to know the opinion and cognition about the agricultural marketing, the Agricultural Marketing Centre and local products. To achieve our goal we made a questionnaire. It was filed by 220 persons. They are – usually – graduated persons; mainly we wanted to reach them.
We have known, the most of the participants had heard about the agricultural marketing, but the main institute, AMC not yet. The AMC programs are not too famous by them, but the other, similar festivals are prominent. We think the reason is the place of the events, the AMC sponsored happenings are in Budapest, the others are in big cities all over the country.
The big part of our survey-responsible have bought local product, because of the quality and the local raw material and healthy lifestyle. Fortunately, they are satisfied with these products, the main problem is the seasonality and the less choice.
Our suggestions are:

- It should be good to organize by AMC minors programmes in the county seats, or big cities
- For the aware consumption at the school, for students have to give talks about the local economy
- Local farmers /producers should be invite children / families, to know their process and products.

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DOI: 10.14232/analecta.2018.2.37-44

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ISSN 2064-7964

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THE PHYSIOLOGICAL EFFECTS OF FISH CONSUMPTION WHY SHOULD WE CONSUME FISH ON A REGULAR BASIS?

[1]Eszter Ács, [2]Brigitta Zsótér
[1-2]University of Szeged, Faculty of Engineering, Economic and Rural Development Department, 7 Mars Square, 6724, Szeged, Hungary
[1]e-mail: acs.eszter.4@gmail.com
[2]e-mail: zsoterb@mk.u-szeged.hu

ABSTRACT

Fish contains nutrients which are essential for our organism, vitamins (for example: A; B_1; B_2; D), minerals and various unsaturated and polyunsaturated fatty acids (for example: Omega 3 fatty acid). The latest cannot be produced by our organism, but indispensable to its normal operation. There is literature on its various effects on the brain, immune system, and it is widely known that it plays a significant role in preventing cardiovascular diseases, since due to its anti-inflammatory effect it is able to cure inflammations on the vascular walls. Omega 3 fatty acids appear mainly in marine phytoplankton and in sea fish in large quantity. We can see that our organism would need regular fish consumption. Researches show that one should take 1 gram of Omega 3 fatty acid on a daily basis. Experts state that fish is one of the indispensable conditions of a healthy diet, so we should consume fish twice a week. Despite the fact that fish is delicious and healthy, it is not part of our everyday menu. The ideal consumption of oily fish would be more than 15 kg/capita/year, but in Hungary this is hardly 4 kg/capita/year.

Keywords: fish consumption, health, way of life, Omega 3 fatty acid

1. INTRODUCTION

We consider the endeavours for a healthy life extremely important. Many food consumption risks are known, but the alternatives to handle them are also available [1]. Fish consumption is a pivotal part of healthy way of life [2]. Numerous professional works have been published on the observations of the effects of food-producing companies [3] and on food-industrial investments [4]. It justifies my topic choice that earlier Zsótér and Kaliczka [5] also dealt with the examination of consumer habits.

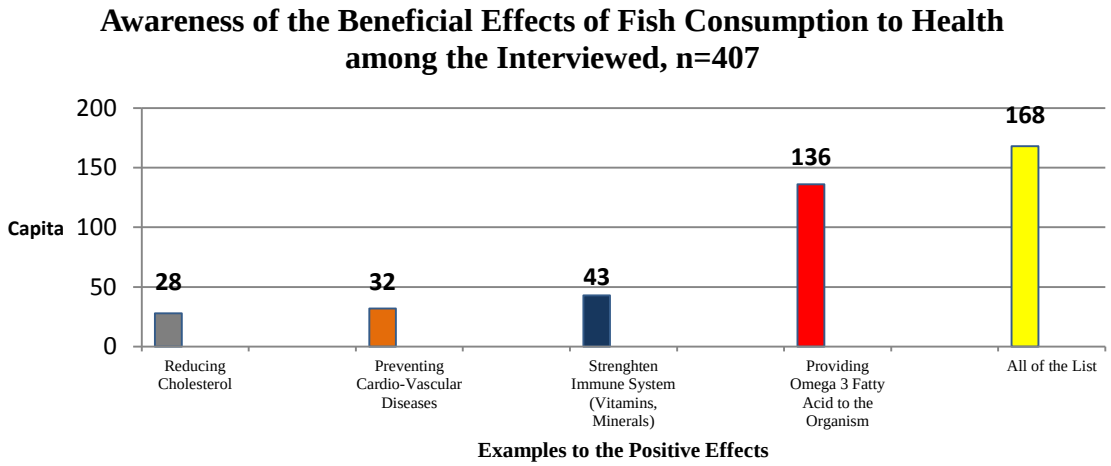

Figure 1. Diagram on the Awareness of Benefits of Fish Consumption

DOI: 10.14232/analecta.2018.2.45-50

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The major part of nutrient sources, vitamins (e.g.: A; B_1; B_2; D), minerals and various unsaturated and polyunsaturated fatty acids (e.g.: Omega 3 fatty acid) essential to our organism can be ensured by consuming more fish [6]. The diagram above shows that the majority of the interviewed consider fish meat really healthy. They assume that all of the listed beneficial effects play a role if we consume fish regularly. However, the most known advantage seemed to be the intake of Omega 3 fatty acid, which is not surprising, since it has got the largest publicity. The favourable effects – among others – can be attributed to the loose structure of fish meat. It is easily digestible to our organism. It has an ideal energy/fat-content. Its protein content is average 15-20%, so it can be well applied in weight-loss diets. We can distinguish fish rich in fat (e.g.: carp, catfish, tuna, mackerel, salmon and herring) and fish types which are not so fatty (e.g.: silver carp, amur, bass, cod and hake). The number of death incidents due to heart disease showed 52% lower occurrence at those who consumed fish at least weekly than those who consumed fish once a month. This is justified by a research in 2000, which was carried out by Hungarian Gastronomic National Association [7].

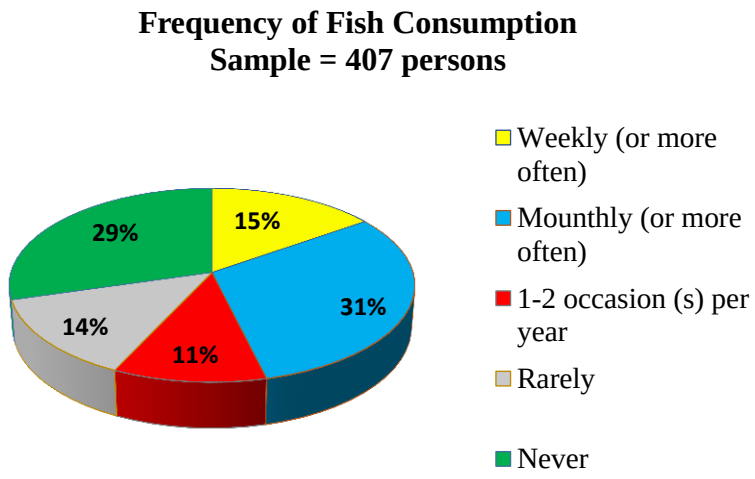

Figure 2. Chart on the Frequency of Fish Consumption

In our investigation we aimed to assess the frequency of fish- and fishproduct consumption of the students nowadays in Miklós Radnóti Secondary Grammar School in Szeged. Thanks to the small edible fishbones, which are typically found in canned fishproducts, we additionally could also get Calcium. Fat soluble vitamins (such as vitamins A and D) can be provided to our body by incorporating fishmeat into our diet.
This is extremely important, because so our organism can neutralize the free radicals (i.e.: the materials originating from physiological processes as well as getting into the body from outside source, which damage tunica and cause cancer-related diseases). From water soluble vitamins fish contains B1 and B2 in larger quantities. Regarding minerals, its iron, selenium, zinc and iodine content is significant [8].

DOI: 10.14232/analecta.2018.2.45-50

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2. MATERIALS AND METHODS

The last year another project was conducted [9], and the methodology of that is the same as of this current one. The period of the survey is being modified to the months of September and October, 2018. 407 students filled in our questionnaire in Miklós Radnóti Secondary Grammar School.
The basis of our primary research was a questionnaire compiled by us, filled in by secondary school students. The interviewers were us—fostering the proper fill. In the secondary grammar school former teachers ensured possibility to fill in the questionnaire during lessons and head teacher's lessons, with which students helped our work. Our questionnaire consisted of 15 questions, of which 10 questions related to fish consumption habits and relevant opinion of the interviewed, and 5 questions revealed demographic data. Most of the questions were closed ones.
After compiling the questionnaire, we have conducted a test fill-in in the beginning of September, 2018. With this, it could turn out if the logical built-up of the questionnaire is appropriate and the types of questions are ideal [10]. The number of interviewed was 411 altogether, but 4 of the questionnaires could not be evaluated, so during the evaluation we were examining a sample of 407. We have informed the persons involved in the research both about the aim of this current work and about the fact that we have handled the given data with full respect for personal rights [11]. We have evaluated the questionnaires with the PSPP statistical system, which substitutes the patented Statistical Package for the Social Sciences, SPSS program [12]. We have chosen this possibility so that we could process data effectively and fast [13]. PSPP is excellent to compare results from analyses [14]. We have conducted hypothesis investigation using Z-test, where we claim a thing and check on the basis of a pattern appearing during the investigation if it is also true for the whole lot with given (95%) probability [15]. A similar questionnaire-based survey was conducted in 2010 [16]. The Hungarian food economy, besides encouraging fish consumption, has to face many challenges [17].

3. RESULTS AND DISCUSSION

In view of scope limits, we do not publish the details of the research results in this study, this part of this paper focuses on sharing the final results of hypothesis examination.

2.1. One of the hypotheses

According to minimum 50% of the interviewed regular fish consumption is beneficial to health.

n=407 (size of the sample)
k=349 (number of interviewed according to null hypothesis)
P=0.5000 (the expected value)
p=k/n=0.8575(value counted from sample)

Agree with the statement above: 349 persons.
Do not agree with the statement above: 58 persons.
Summa interviewed: 407 persons.

Z-test: H_0: $p \geq 0.5$ ← Null hypothesis.
H_A: $p < 0.5$ ← Alternative hypothesis, on the basis of relation sign left-side test.
↓
(At a left-side test we accept null hypothesis if z-value > critical value.)

Level of Significance: $\alpha=0.05$ (error probability)
Range of acceptance (critical value): $Z_{0.05}= -1.645$

DOI: 10.14232/analecta.2018.2.45-50

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Z-Test Value: $Z = \frac{k-nP}{\sqrt{nP(1-P)}}$ or $Z = \frac{p-P}{\sqrt{\frac{P(1-P)}{n}}}$ **Result of Z-Test: 14.42**

Statistical Conclusion: Z-Test value is bigger than critical value →
We accept null hypothesis at a 5% significance level, and in the case of 95% probability.

Professional Conclusion:
According to minimum 50% of the interviewed, regular fish consumption is beneficial to health.

2.2. Another hypothesis

The majority of the interviewed (>50%) think that fish consumption should be increased.

n=407 (size of the sample)
k=280 (number of interviewed according to null hypothesis)
P=0.5000 (the expected value)
p=k/n=0.688 (value counted from sample)

Agree with the statement above: 280 persons.
Do not agree with the statement above: 127 persons.
Summa interviewed: 407 persons.

Z-test: H_0: $p \geq 0.5$ ← Null hypothesis.
H_A: $p < 0.5$ ← Alternative hypothesis, on the basis of relation sign left-side test.
↓
(At a left-side test we accept null hypothesis if z-value > critical value.)

Level of Significance: α=0.05 (error probability)
Range of acceptance (critical value): $Z_{0.05} = -1.645$

Z-Test Value: $Z = \frac{k-nP}{\sqrt{nP(1-P)}}$ or $Z = \frac{p-P}{\sqrt{\frac{P(1-P)}{n}}}$ **Result of Z-Test: 7.5855**

Statistical Conclusion: Z-Test value is bigger than critical value →
We accept null hypothesis at a 5% significance level, and in the case of 95% probability.

Professional Conclusion:
Fish consumption should be increased according to the majority of the interviewed.

4. CONCLUSIONS

We can see that fish consumption is a pivotal part of a healthy lifestyle, but we do not integrate it sufficiently into our everyday diet. Excessive presence of seasonality can be observed in fish consumption, despite the fact that our article containing the results of our research as well as numerous other research prove the wide scale of fish consumption's beneficial effects on our organism. We propose fish consumption at a regular basis. In our view, domestic fish consumption could be increased if people could purchase excellent quality (and very importantly fresh) fish in several places.

DOI: 10.14232/analecta.2018.2.45-50

We also propose even a more pronounced advertising of the benefits of fish to human organism, a clear awareness of this to the people who are currently non-consumers of fish, since many are not aware how much the numerous vitamins, minerals and unsaturated fatty acids in fish support human organism. We are reassured that the more people are aware of these important pieces of information, the more will consume fish. We find it important that rising awareness should take place in various fields. We feel that attention should be called in schools, too, that fish consumption plays an extraordinary role for our health care. If the student meets already during school years the importance of the endeavour for a healthy way of life as well as its tools (e.g.: fish consumption), in their adulthood, while independent, will take actions for this with higher probability. Summarising information on this topic, we can state that fish consumption is healthy and at the same time it is necessary, too.

ACKNOWLEDGEMENT

Eszter Ács is supported by the UNKP-18-1 New National Excellence Program of the Ministry of Human Capacities.

EMBERI ERŐFORRÁSOK MINISZTÉRIUMA

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DOI: 10.14232/analecta.2018.2.45-50

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ISSN 2064-7964

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ENERGY AND RENEWABLE ENERGY USE IN EU28 AND HUNGARY ON THE BASIS OF STATISTICS

[1]Judit Csizmásné Tóth, [2]Zsolt Hollósy, [3]Judit, Poór

[1]Department of Economics, Finance and Accounting, Faculty of Economy, John von Neumann University, Tiszaligeti sétány 14, 5000, Szolnok, Hungary, e-mail: judy.toth@gk.uni-pannon.hu

[2]Department of Economic and Social Sciences and Rural Development, Georgikon Faculty, University of Pannonia, Deák F. Str. 16., 8360 Keszthely, Hungary, email: hollosy@georgikon.hu

[3]Department of Economic Methodology, Georgikon Faculty, University of Pannonia, Deák F. Str. 16., 8360 Keszthely, Hungary, email: pj@georgikon.hu

ABSTRACT

This paper presents the expansion of renewable energy sources of electricity generation over the last 10-15 years, based on statistical data for Hungary and for the EU-28 member states. The share of renewable energy in electricity production was almost 30% in the EU28 in 2016, while in Hungary it was only 7%, which is the second lowest share in EU member states. In Hungary, the share of nuclear energy is still high in electricity production, and the proportion of biomass in renewable energy in Hungary is very high compared to the EU-28 average. An important issue for Hungary is how to reduce the share of nuclear energy in the longer term. Finally, the paper highlights the essential elements of the Hungarian METAR subsidy system aimed at encouraging the production of electricity (and heat) energy from renewable energy sources while minimizing the burden on end users.

Keywords: energy policy, renewable energy targets for shares of total energy and of electricity, gross domestic energy consumption, renewable energy use

1. INTRODUCTION

The people are increasingly aware of the need for renewable energy and energy efficiency to cover the increasing global energy demand (see Fig. 1) and to handle climate change, which creates new economic opportunities and can provide energy for billions of people who live without modern energy services. So the numbers of the countries with renewable energy policies and targets have grown dynamically over the past decade, and the statistics on renewable energy production also indicate a significant expansion.

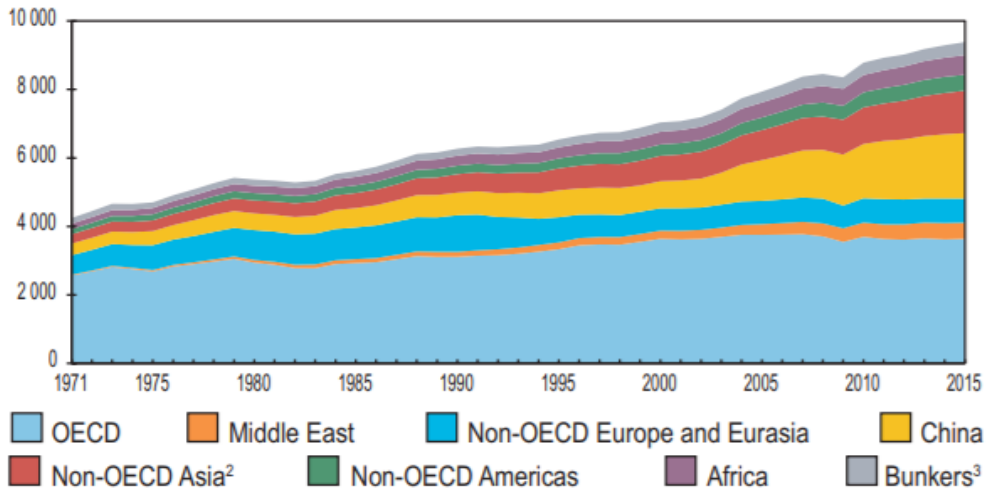

Figure 1. World total final energy consumption from 1971 to 2015 (Mtoe) Source: [1]

DOI: 10.14232/analecta.2018.2.51-56

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The results of the implementation of a range of policies including targets, regulations, public financing and fiscal incentives are also reflected in the statistics of the world's energy production and consumption. According to the Global Status Report [2], 16.7% of the world's primary energy was provided by renewable energy in 2004. Traditional biomass used mainly in remote rural areas in developing countries primarily for cooking and heating represented 9.0% and the share of large hydropower was 5.7%. The so-called new renewables were 2.0% (0.2% biofuel, 0.7% hot water/heating, 1.2% power generation). The REN21 Global Status Reports have published the ratios for the final energy use since 2006, so we can compare the latest statistics back to 2006. At that time, a decade ago, the renewable energy accounted for 18.0% of the total final energy consumption (TFEC) (traditional biomass: 13.0%, large hydropower: 3.0%, hot water/heating: 1.3%, power generation: 0.8%, biofuel 0.3%) [3]. On the basis of the latest statistics (GSR, 2018) modern renewables (without traditional use of biomass the share of which was 7.8% of TFEC) accounted for 10.4% of TFEC, most of which (5.4%) was generated by renewable electricity (the greatest portion (3.7%) is of hydropower). The renewable thermal energy (biomass/solar/geothermal heat) accounted for 4.1% and it was followed by transport biofuels (0.9%). So the combined renewable energy was 18,2% in TFEC in 2016.

The overall share of renewable energy seems to increase modestly over the past ten years but a significant rearrangement can be identified. While the average 10-year growth rate of the TFEC was 1.7%, the rate of the traditional biomass was only 0.2%. So the traditional use of biomass has grown but not to the extent as TFEC therefore the decline of its share in TFEC. Meanwhile some renewable sectors are characterized by tremendous growth, the average 10-year growth rate of modern renewables was 5.4%.

According to the GSR [4] the supply of renewable electricity generation increased 56.6% in the period from 2007 to 2015 thanks to more attention of policy makers to renewable power generation. During this period the supply of modern renewable heat increased 20.5%, and in 2015 modern bioenergy (excluding traditional biomass) accounted for the majority of renewable heat. As renewable heating and cooling so far received less attention despite accounted for 48% of TFEC in 2015 (Fig. 2) it can be identified as the "sleeping giant of renewable energy potential" similar to transport. Transport accounted for 32% of TFEC and the majority (more than 90%) of global energy needs of the sector are still met by oil. The proportion of biofuels was around 8%, while electricity accounted for only 1%. Figure 2 represents the share of the sectors in TFEC and the role of renewable energy by sector. On the basis of Figure it can be seen that renewable electricity can be used for electricity consumption or even heating/cooling and transport.

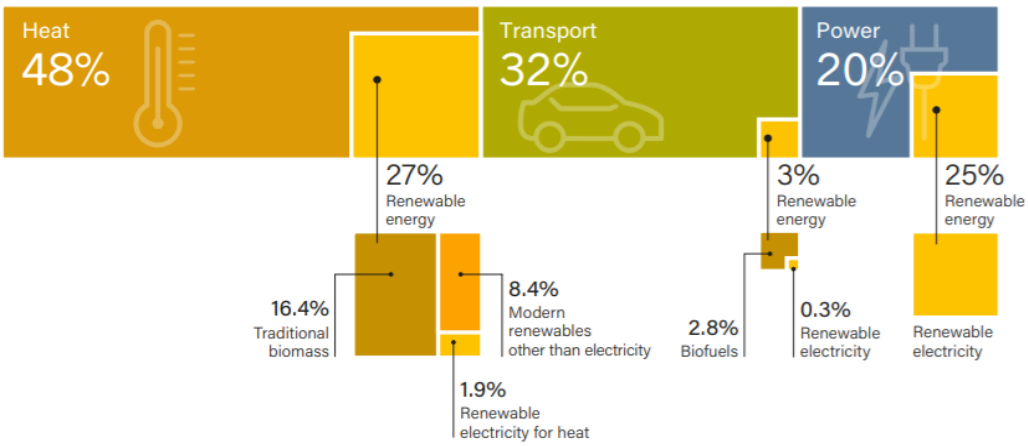

Figure 2. Renewable energy in TFC by sector, 2015 [4]

DOI: 10.14232/analecta.2018.2.51-56

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Total renewable power capacity more than doubled in the last decade and it has the largest annual increase in 2017 thanks to primarily solar PV accounted for nearly 55% of newly installed renewable power capacity. Global renewable power capacity supply 26.5% of global electricity with hydropower providing 16.4% and wind power accounting for 5.6%.

2. SHARE OF ELECTRICITY FROM RENEWABLE SOURCES IN THE EU MEMBER STATES

The share of electricity from renewable sources in gross electricity consumption is very different between EU member states. More than three fifths of all the electricity consumed was generated from renewable energy sources — largely as a result of hydro power and solid biofuels — in Austria (72.6 %) and Sweden (64.9 %) while the share of electricity generated from renewables was more than 50% in Portugal (54.1 %), Denmark (53.7 %) and Latvia (51.3 %) (Fig. 3). In Cyprus, Hungary, Luxembourg and Malta the share of electricity came from renewable energy sources was less than 10 % (Fig. 3).

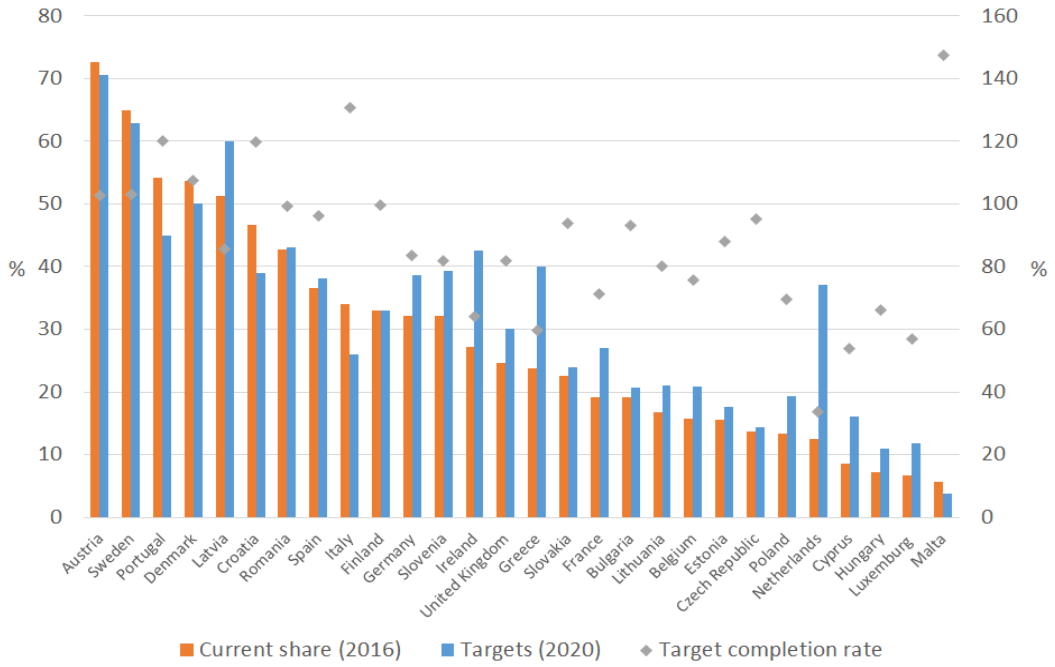

Figure 3. Targets and share of electricity from renewable sources in EU-28 Source: On the basis of EUROSTAT, own edition

In 2016, electricity generation from renewable sources contributed 30% to total EU-28 gross electricity consumption (Fig. 4).

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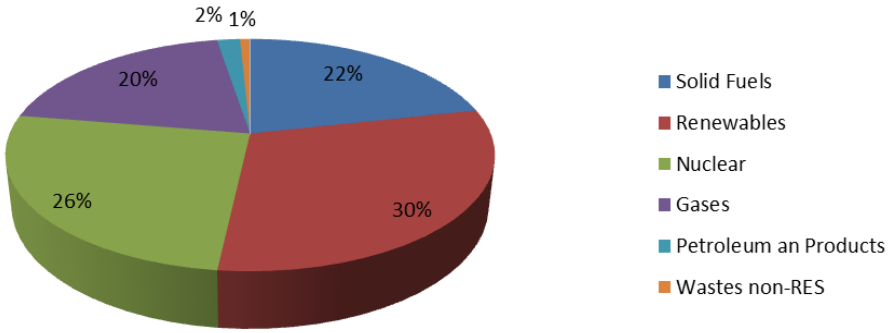

Figure 4. Gross electricity generation by fuel in EU-28 (2016) [5]

During the period 1990 to 2016 the electricity generated in the EU-28 from renewable energy sources rose from 13% to 30% (Fig. 5). The growth in electricity generated from renewable energy sources largely reflects an expansion in three renewable energy sources across the EU, principally wind power, but also solar power and solid biofuels (including renewable wastes).

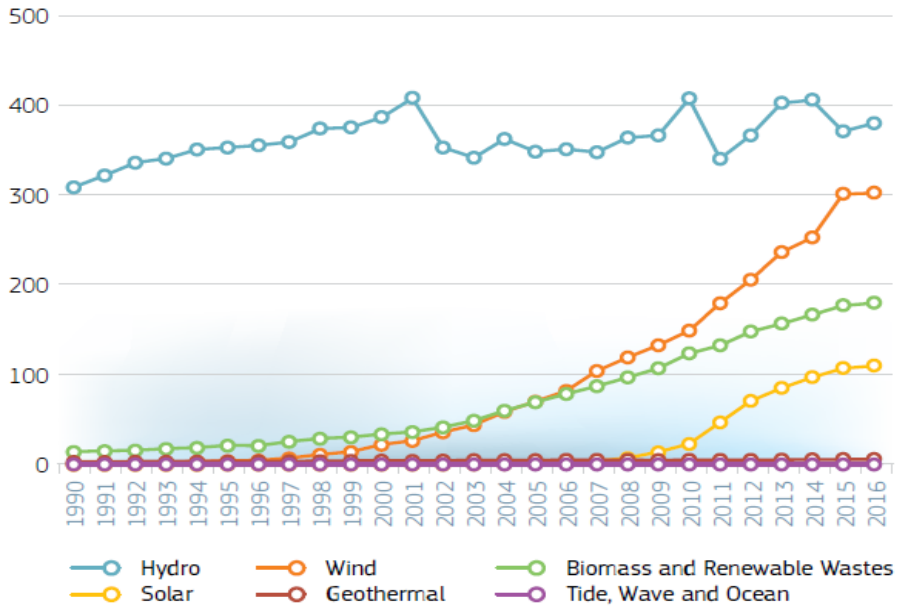

Figure 5. Renewables from gross electricity generation in EU-28 (1990-2016) [5]

Hydro power was the most important source for renewable electricity generation in the EU-28 in 2016 (37 %), followed closely by wind power (32%) biomass (18%), and solar power (12%) (Fig. 6).

DOI: 10.14232/analecta.2018.2.51-56

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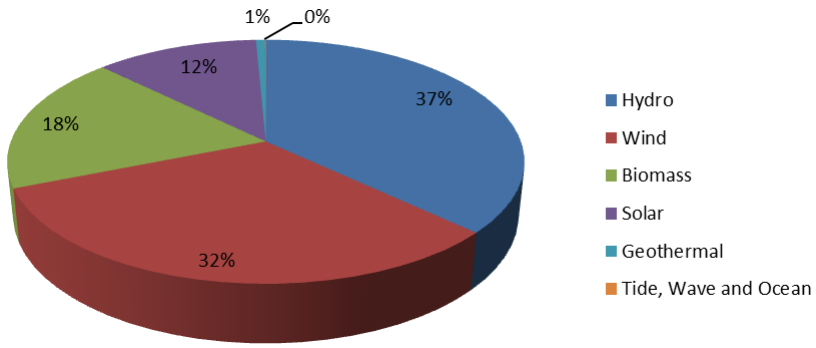

Figure 6. Renewables from gross electricity generation in EU-28 (2016) ***[5]***

3. SHARE OF ELECTRICITY FROM RENEWABLE SOURCES IN HUNGARY

The share of Hungary is significantly different from the shares of the European Union. While in the European Union 30% of all the electricity consumed was generated from renewable energy sources, only 7% in Hungary which was the second lowest share in the EU.
The share of nuclear power (52%) is very high in electricity generation (Fig. 7). According to nuclear strategy Hungary aims to maintain nuclear capacity over the long term, that is reconstruct new units parallel with the uprate and lifetime extension of the existing units. [6]

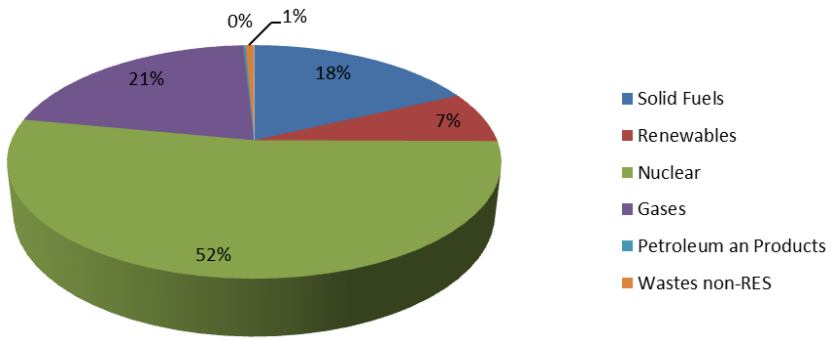

Figure 7. Gross electricity generation by fuel in EU-28 (2016) ***[5]***

On the basis of the latest statistics in Hungary 65% of renewable electricity generation was generated by biomass, 21% by wind, 8% by hydro power and by 6% by solar energy [5].
In Hungary, the share of renewables in TFEC shows a significant increase since 2005 (Fig. 8). In 2016 the rate of renewables was 14.19%. Although this exceeds the 13% target set by the Renewable Energy Directive as a mandatory target of 2020, however, the most of this is provided by biomass, which is a renewable energy source but more than questionable whether it can be called clean.

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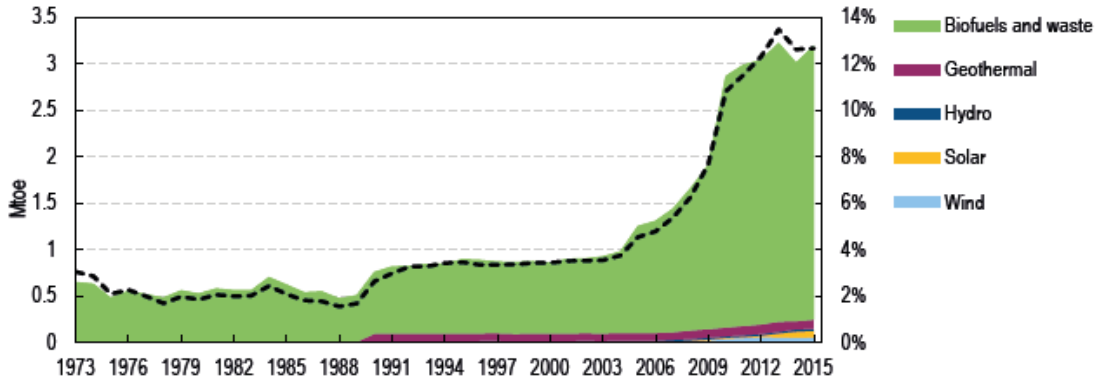

Figure 8. Renewables energy in Hungary as a percentage of TPES (1973-2015) **[6]**

4. METÁR SUPPORT SYSTEM IN HUNGARY

In Hungary in 2017, a new operational support system (METÁR) was introduced for renewables-based electricity generation. The previous support system (KÁT) continues to operate for existing plants following the introduction of METÁR, however, only new entrants will be eligible for the METÁR support mechanism. This new mechanism facilitates the integration of renewable electricity producers into the market, and supports the fulfillment of Hungary's 2020 renewable energy targets [6].
METAR subsidies can be granted for electricity generation that is linked to a new investment. Existing power plant units may also be eligible for support that will undergo major renovations or upgrades, with a cost exceeding 50% of the original initial investment cost. Combustible or waste incineration plants can only receive support (renewable energy proportionate) for renewable energy sources [7].
METÁR will also introduce a brown premium for depreciated biomass and biogas power producers to avoid the shutdown of these plants or the switch to fossil fuels in depreciated plants. METÁR contains strong guarantees regarding the usage of wood as fuel for electricity generation in order to prevent illegal logging and to protect forests [6].

ACKNOWLEDGEMENT

This research is supported by EFOP-3.6.1-16-2016-00006 "The development and enhancement of the research potential at John von Neumann University" and EFOP-3.6.1-16-2016-00015 (financial support of Széchenyi 2020) project. Projects are supported by the Hungarian Government and co-financed by the European Social Fund.

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DOI: 10.14232/analecta.2018.2.51-56