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INNOVATIVE SOLUTIONS OF DEVICES WITHIN THE SCOPE OF ENERGY CONSUMPTION APPLIED IN VARIOUS BRANCHES OF TRANSPORT

Summary. One of the priorities of the EU economy is to create the best possible conditions for the design and implementation of innovative solutions within the scope of energy efficiency. In recent years, there has been quick technological progress in the field of devices having controlled motor drive used for air purification, and from heating plates, which are applied in the eating places, including restaurants and zones for preparing meals in various means of transport. The research conducted by the EU on EcoDesign requirements showed that range hoods at the stage of their use have a considerable potential of saving energy. The introduction of energy efficiency labels to the market has improved the energy efficiency of these devices and accelerated the transformation of the market to implement energy-saving technologies, which according to the experts, may lead to an annual primary energy saving of 27 PJ/year in 2021, which may increase in

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2030 to 60 PJ/year. The authors of this publication researched the fluid dynamic efficiency of a selected range hood, showing the necessity of investments in new technologies. Patented original solutions of the range hoods that can be applied, among others, in such means of transport as passenger ships, cargo ships, and submarines having a zone for preparing meals were presented in this article. An environmental aspect in the context of energy consumption was shown during the phase of using the device for air purification, providing many premises and arguments for future constructional solutions for energy management in various branches of transport and more.

Keywords: energy-saving technologies, energy efficiency, energy consumption, means of transport, range hood

1. INTRODUCTION

Modern technical solutions allow to considerably reduce energy demand. Increasingly, more people pay attention to energy classes of devices. New models of devices are produced in higher energy classes; they are also equipped with the options of additional energy saving, eco modes and other solutions that allow for minimizing operating costs. Further, they also have an impact on the environment [1-3]. These factors are very important in the case of implementation of household appliances in various means of transport, for example, on ships (galley), both passenger and cargo ones, or in buffet cars, in which space for preparing meals is adopted (Figure 1).

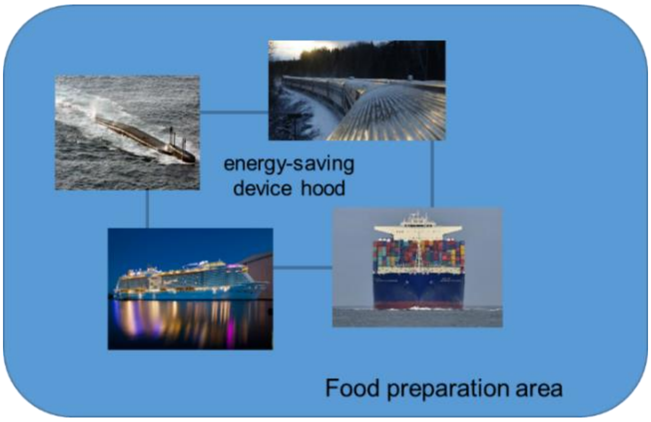

Fig. 1. Means of transport with food preparation areas

The use of energy-saving equipment reduces both the amount of absorbed energy and the production of electric energy, resulting in decreased carbon dioxide emission [4-6]. Internal calculations and forecasts of the European Commission showed that the total annual final energy saving due to the new labelling until 2030 may even be 60 PJ/year [7].

Therefore, there are many premises for the economical management of energy as an important resource [8-9]. However, not everyone is aware of the negative impact of incautious energy management on the natural environment [10]. We do not always realize that individual contribution to environmental protection is the sensible use of energy-saving devices, especially those implemented in branches of transport, which also results in saving money [3], [11-12].

Recently, there has been quick technological progress in the field of household appliances, especially in the reduction of their energy consumption [13-14]. Resulting from the analyses conducted by the European Commission, the EU energy label introduced in 1995 has turned out to be a success. The results of conducted research show that 85% of European consumers consider it when shopping [7]. To make actions connected with control of conformity of labelling with the level of energy consumption more effective and efficient, a database for registering products (European Registry for Energy Labelling - EPREL) was created [15]. In this database, the producers and importers have to register their products, including detailed technical documentation necessary to control the conformity of energy consumption.

Research has shown that household appliances, including range hoods, have a large potential for saving energy [17-18]. Energy efficiency labels placed on these devices provide the users' information about:

- Fluid dynamic efficiency (FDE_{hood}),
- Energy efficiency index (EEI_{hood}),
- Lighting efficiency (LE_{hood}),
- Grease filtering efficiency (GFE_{hood}).

The values of the indicators on the labels are used by both the producers and the authors of this publication as a factor pressurizing to look for other solutions to improve the energy efficiency of these devices. It is connected with speeding up new solutions and implementation of energy-saving technologies, including applications for a patent to the patent offices. Conducted analysis of the literature showed a lack of indication of original modern solutions improving energy consumption of ventilation hoods and the possibility of implementation of these solutions in the zones for preparing meals in various means of transport.

This article aimed to research on fluid dynamic efficiency of selected ventilation hoods, showing the necessity of investing in new technologies. Towards this end, the stand to examine the flow rate of the fans for ventilation hoods was used following standards applicable in the European Union.

2. ENERGY EFFICIENCY OF RANGE HOODS

According to the values presented in Table 1, the energy efficiency classes of range hoods are determined.

Tab. 1

Energy efficiency classes of range hoods [19]

Energy Efficiency Class	**Energy Efficiency Index (EEI_{hood})**			
	Label 1	**Label 2**	**Label 3**	**Label 4**
A+++ (the most efficient)				$EEI_{hood} < 30$
A++			$EEI_{hood} < 37$	$30 \leq EEI_{hood} < 37$
A+		$EEI_{hood} < 45$	$37 \leq EEI_{hood} < 45$	$37 \leq EEI_{hood} < 45$

A	$EEI_{hood} < 55$	$45 \leq EEI_{hood} < 55$	$45 \leq EEI_{hood} < 55$	$45 \leq EEI_{hood} < 55$
B	$55 \leq EEI_{hood} < 70$	$55 \leq EEI_{hood} < 70$	$55 \leq EEI_{hood} < 70$	$55 \leq EEI_{hood} < 70$
C	$70 \leq EEI_{hood} < 85$	$70 \leq EEI_{hood} < 85$	$70 \leq EEI_{hood} < 85$	$70 \leq EEI_{hood} < 85$
D	$85 \leq EEI_{hood} < 100$	$85 \leq EEI_{hood} < 100$	$85 \leq EEI_{hood} < 100$	$EEI_{hood} \geq 85$
E	$100 \leq EEI_{hood} < 110$	$100 \leq EEI_{hood} < 110$	$EEI_{hood} \geq 100$	
F	$110 \leq EE_{Ihood} < 120$	$EEI_{hood} \geq 110$		
G (the least efficient)	$EEI_{hood} \geq 120$			

The indicator energy efficiency index (EEI_{hood}), which is rounded to the first decimal place (1) [19]:

$$EEI_{hood} = \frac{AEC_{hood}}{SAEC_{hood}} \times 100 \tag{1}$$

where: $SAEC_{hood}$ - the standard annual energy consumption of the range hood [kWh/year], AEC_{hood} - the annual energy consumption of the range hood [kWh/year]

The standard annual energy consumption ($SAEC_{hood}$) of a range hood determination (2):

$$SAEC_{hood} 0{,}55 \times (W_{BEP} + W_L) + 15{,}3 \tag{2}$$

where: W_{BEP} - at the optimum operating point of the hood, we determine the power consumption [W], W_L - rated power consumption by the hood lighting system illuminating the heating surface [W].

The annual energy consumption (AEC_{hood}) of the range hood is calculated as [19]:

– for automatic (3)

$$AEC_{hood} = [\frac{(W_{BEP} \times t_H \times f) + (W_L \times t_L)}{60 + 1000} + \frac{P_o \times (1440 - t_H \times f)}{2 \times 60 \times 1000} + \frac{P_s \times (1440 - t_H \times f)}{2 \times 60 \times 1000}] \times 365 \tag{3}$$

– for other types (4):

$$AEC_{hood} = [\frac{[W_{BEP} \times (t_H \times f) + W_L \times t_L]}{60 + 1000} \times 365 \tag{4}$$

where: t_L - the average work lighting time per day [min] (t_L = 120), t_H - the average work running time per day [min] (t_H = 60), P_o - the electric power input in off state [W], P_s - the electric power input in readiness mode [W], f - the time increase factor, as (5)

$$f = 2 - (FDE_{hood} \times 3{,}6)/100 \tag{5}$$

Depending on the obtained values (FDE_{hood}), the fluid dynamic efficiency class is determined (Table 2).

Tab. 2
Fluid dynamic efficiency classes for range hoods [19]

Fluid Dynamic Efficiency Class	**Fluid Dynamic Efficiency (FDE_{hood})**
A (the most efficient)	$FDE_{hood} > 28$
B	$23 < FDE_{hood} \leq 28$
C	$18 < FDE_{hood} \leq 23$
D	$13 < FDE_{hood} \leq 18$
E	$8 < FDE_{hood} \leq 13$
F	$4 < FDE_{hood} \leq 8$
G (the least efficient)	$FDE_{hood} \leq 4$

From formula (6), we calculate the fluid dynamic efficiency value at the optimal point.

$$FDE_{hood} = \frac{Q_{BEP} \times P_{BEP}}{3600 \times W_{BEP}} \times 100 \tag{6}$$

where: Q_{BEP} -the flow rate of the range hoods at the best efficiency point [m^3/h], P_{BEP} – the static pressure difference at the best efficiency point [Pa], W_{BEP} - at the point of best efficiency, electric power consumption [W]

Where air flow rates in any available operating mode exceed 650 m^3/h, the hoods must automatically switch to an air flow rate not exceeding 650 m^3/h during tlimit. This is the amount of time needed to extract 100 m^3 of air through a hood operating at an air flow rate of more than 650 m^3/h before automatically switching to operation at an air flow rate of less than 650 m^3/h. It is calculated in minutes (7), (8):

$$t_{limit} = \frac{6000 m^3}{Q_{max}} \tag{7}$$

$$\mathrm{v} = \int_0^t \frac{Q_{max}}{60} \times dt \quad \textit{witch can be simplified to} \quad t_{limit} = \frac{V_{max}}{Q_{max}} \tag{8}$$

where Q_{max} - max air flow rate turbo mode m^3/h, V_{max} - max size of air stamped, set at 100 m^3, Q_{max} max air flow, if the hood is equipped with turbo mode, t - time [min], dt- total time as a result of which the amount of air was reached of 100 m^3, t_{limit} - the time it takes to bring in 100 m^3 air.

The lighting efficiency parameter (LE_{hood}) affects the class range hood (Table 3).

Tab. 3

Lighting efficiency classes [19]

Lighting Efficiency Class	**Lighting Efficiency (LE_{hood})**
A (the most efficient)	$LE_{hood} > 28$
B	$20 < LE_{hood} \leq 28$
C	$16 < LE_{hood} \leq 20$
D	$12 < LE_{hood} \leq 16$
E	$8 < LE_{hood} \leq 12$
F	$4 < LE_{hood} \leq 8$
G (the least efficient)	$LE_{hood} \leq 4$

The ratio of the average illuminance to the nominal electric power consumption of the lighting system is expressed by the coefficient lighting efficiency (LE_{hood}) (9):

$$LE_{hood} = \frac{E_{middle}}{W_L} \tag{9}$$

where: E_{middle} - average illumination of the oven hob [lux], W_L - rated power consumption of the oven surface [W].

According to Table 4, the classes are determined (GFE_{hood}).

Tab. 4

Grease filtering efficiency classes for range [19]

Grease Filtering Efficiency Class	**Grease Filtering Efficiency (%)**
A (the most efficient)	$GFE_{hood} > 95$
B	$85 < GFE_{hood} \leq 95$
C	$75 < GFE_{hood} \leq 85$
D	$65 < GFE_{hood} \leq 75$
E	$55 < GFE_{hood} \leq 65$
F	$45 < GFE_{hood} \leq 55$
G (the least efficient)	$GFE_{hood} \leq 45$

Impurities deposited on the hood filters affect the parameter (GFE_{hood}) (10):

$$GFE_{hood} = [w_{g/}(w_r + w_t + w_{g)}] \times 100[\%] \tag{10}$$

where: w_g - the mass of impurities in the filter, w_r - the mass of fat on the hoses, w_t -the mass of grease inside the filter.

3. STAND TESTING FLOW OF THE FANS IN THE RANGE HOODS

The test stand can be used to trace the curves of any single-phase AC electric fan (either 50Hz or 60Hz), normalizing them to the settable environmental reference parameters. In particular, it is possible to trace the curves for static pressure, total pressure, aerolic power, electrical power consumption, operating current, impeller rotation speed and global efficiency with great accuracy as a function of normalized flow through an unlimited number of measurement points. Furthermore, it is also possible to measure the losses for passive elements such as filters or pipes. All test phases are completely software guided and assisted, minimizing the operator's intervention. Figure 2 shows the stand for fan flow testing for range hoods according to ISO 5801, ISO 5167, IEC 61591 and IEC 61591 / A11.

Parameters of the test stand:

- Maximum volumetric flow: 1600 [Nm^3/h]
- Maximum pressure: from -250 to +850 [Pa]

Fig. 2. Flow test bench for fans range hood

The functional elements of the test stand are shown in Figure 3.

The test bench consist of: plexiglass test chamber 15[mm] in 4 sections; useful section= 900 x 900 x 4500 [mm], Input flange = 600*400 [mm]. All the static pressure outlets are attached to the longitudinal (4 outlets x 3 sections = 12 outlets according to ISO5761) with the related hydraulic connections to the pressure transmitters, the transmitters themselves and the humidity and temperature sensors, as well as all of the electrical wiring. Group of 5 calibrated nozzles of the long radius - low ratio type (compliant with ISO5761) to measure the flow rate. Configurable full scale, closing the unnecessary nozzles before testing, from 60[m^3/h] to 2400[m^3/h] with steps of 120[m^3/h], to ensure maximum accuracy for each tested fan size. Flow homogenisation screens created with the use of grille sequences in compliance with ISO 5801. Continuous counter-pressure regulation (from completely closed to completely open) using gate valves or the equivalent. Continuous regulation recovery fan (by an inverter). In the test stand, a centrifugal fan of appropriate capacity is used, driven by a three-phase motor controlled by an inverter, which allows continuous regulation of the booster speed.

The station provides a complete measurement chain: sensors, data acquisition device, personal computer (PC), acquisition software, data processing and display, and control console and the general power panel for the measurement path + PC. The entire test procedure is managed through the software, from the stand commissioning checklist to the setting of test parameters and execution of the test. No post-processing is required for the data obtained, as the calculation and presentation of standard reports take place automatically and interactively each time the test is run. The implemented software provides test data for hoods, fans and filters. Similarly, the supplied software provides test data for hoods, fans and filters.

Fig. 3. Functional elements of the test stand: 1 – Calm air chamber, 2 – Booster, 3 – Housing for electric fan under testing, 4 – Observation window, 5 – Variac, 6 – Aluminium profile to support the bench, 7 – Electric panel, 8 – Panel with nozzles

It allows us to perform the measurements and calculations (formulas 1-10) following the regulations of the European Union (EU) 66/2014 and (EU) No. 65/2014 in force in Poland:

- Fluid dynamic efficiency $FDE_{hood,}$
- Air flow rate measured at the optimal operating point Q_{BEP} [m^3 /h],
- Air pressure measured at the optimal operating point P_{BEP} [Pa],
- Power consumption measured at the optimal operating point W_{BEP} [W],
- Annual energy consumption AEC_{hood} [kWh/r],
- Time elapsed factor f ,
- Energy efficiency index $EEI_{hood,}$
- Max. air flow Q_{max} [m ^{3} /h],
- Nominal power of the lighting system W_L [W],
- The average illuminance provided by the lighting system on the surface of the E_{middle} [lux],
- Electric power input in standby mode P_s [W],
- Electric power input in off-mode P_o [W],
- Sound power level L_{WA} [dB].

4. RESEARCH AND RESULTS OF PERFORMED TESTS

The authors researched the range hood concerning fluid dynamic efficiency FDE_{hood}. Test of fluid dynamic efficiency was performed for specific gears of a tested range hood. Measuring data concerning measurements such as normalized conditions and environmental conditions were placed on the check card (Table 5). Tables 6 - 8 contain the results of measuring strategies for particular 3-speed gears of a range hood. Measuring results of fluid dynamic efficiency and lighting applied in a range hood are presented in Table 9 (Figures 4 and 5)

Fluid dynamic efficiency class is a value calculated in accordance with a dependency (6). The higher the efficiency class, the more effective extraction/absorption of air per unit of absorbed power by the ventilation hood. Fluid dynamic efficiency FDE_{hood} on the 3rd speed gear was 10,9 in low E class for the selected range hood. The lower class requires actions connected with increasing fluid dynamic efficiency class. We must remember that for potential applications of the range hoods, it is important how much m^3 of air this device can purify within one hour and whether it meets the requirements of energy-saving efficiency. There is no doubt that the implementation of energy efficiency labels requires actions from the hood producers. Moreover, it is a new incentive to conduct further research, develop and search for better energy efficiency of products. Therefore, the authors proposed an original innovative patented solution aimed at increasing the energy consumption of a range hood, under patent nos. Pat. 227789, Pat. 228262.

Tab. 5

Measurement data for FDE_{hood}

<table>
<tr><td>Code attempts</td><td colspan="3">1</td><td colspan="2"></td></tr>
<tr><td>An air inlet</td><td colspan="2">120</td><td colspan="3"></td></tr>
<tr><td colspan="2">Standard</td><td></td><td colspan="3"></td></tr>
<tr><td colspan="3">Details/Differences with reference:</td><td colspan="3"></td></tr>
<tr><td colspan="2">Voltage [V]</td><td>230</td><td colspan="3">Standard conditions</td></tr>
<tr><td colspan="2">Frequency [Hz]</td><td>50</td><td colspan="2">Temperature [°C]</td><td>20</td></tr>
<tr><td colspan="2">collar [mm]:</td><td>120</td><td colspan="2">Relative humidity [%]</td><td>50</td></tr>
<tr><td colspan="2">Warm-up time [min]</td><td>15</td><td colspan="2">Ambient pressure [Pa]</td><td>101325</td></tr>
<tr><td colspan="6">Environmental conditions</td></tr>
<tr><td colspan="2">Gear</td><td>1</td><td>2</td><td>3</td><td></td></tr>
<tr><td colspan="2">Temperature [°C]</td><td>20.99</td><td>20.4</td><td>20.5</td><td></td></tr>
<tr><td colspan="2">Relative humidity [%]</td><td>44</td><td>44</td><td>43</td><td></td></tr>
<tr><td colspan="2">Ambient pressure [Pa]</td><td>100580</td><td>100599</td><td>100600</td><td></td></tr>
<tr><td colspan="2">Estimated Q_{max} [m^3/h]</td><td>160</td><td>300</td><td>400</td><td></td></tr>
<tr><td colspan="2">Estimated P_{max} [Pa]</td><td>160</td><td>300</td><td>400</td><td></td></tr>
<tr><td colspan="2">Transfer zone [mm^2]</td><td>12271.85</td><td>12271.85</td><td>12271.85</td><td></td></tr>
</table>

Tab. 6
FDE $_{hood}$ measurement results for the 1st gear speed of the range hood

Air flow rate	**Pressure**	**Power**	**FDE**	**Tension**	**Current**
Q [m^3/h]	P [Pa]	W [W]	FDE [%]	U [V]	I [A]
92.3	0	44.9	0.0	230.81	0.31
84.3	15	44.1	0.8	229.23	0.30
75.1	22	43.9	1.0	229.24	0.30
67.1	29	43.7	1.2	228.96	0.30
59.1	35	44.9	1.3	231.79	0.30
51.1	38	43.1	1.3	228.34	0.30
39.5	44	43.3	1.1	229.02	0.30
29.8	50	43.7	0.9	230.06	0.30
0.2	74	43.3	0.0	230.05	0.29

Tab. 7
FDE $_{hood}$ measurement results for the 2nd gear speed of the range hood

Air flow rate	**Pressure**	**Power**	**FDE**	**Tension**	**Current**
Q [m^3/h]	P [Pa]	W [W]	FDE [%]	U [V]	I [A]
178.1	0	65.3	0.0	229.53	0.46
170.1	13	65.1	0.9	229.44	0.46
161.2	20	64.7	1.4	229.20	0.45
153.1	28	64.7	1.8	229.60	0.45
145.1	36	64.1	2.3	229.10	0.45
137.0	70	64.6	4.1	231.04	0.44
129.0	84	63.1	4.8	229.67	0.43
121.0	109	62.7	5.8	230.50	0.43
109.9	126	61.5	6.3	229.78	0.42
101.3	126	60.4	5.9	228.25	0.42
93.3	145	61.0	6.2	230.51	0.42
51.4	172	58.5	4.2	229.46	0.40
0.4	193	55.7	0.0	227.64	0.39

Tab. 8
FDE $_{hood}$ measurement results for the 3rd gear speed of the range hood

Air flow rate	**Pressure**	**Power**	**FDE**	**Tension**	**Current**
Q [m^3/h]	P [Pa]	W [W]	FDE [%]	U [V]	I [A]
323.1	0	119.3	0.0	229.73	0.91
314.0	42	117.1	3.1	230,29	0.89
255.4	140	106.4	9.3	230.50	0.81
244.5	154	104.7	10.0	230.61	0.81
233.6	166	103.3	10.4	230.73	0.80
225.6	173	101.4	10.7	229.90	0.79
217.5	179	99.0	10.9	228.31	0.78

209.6	186	100.2	10.8	230.70	0.78
201.5	193	99.0	10.9	230.67	0.78
193.5	198	97.4	10.9	230.06	0.77
185.5	202	96.2	10.8	229,63	0.76
177.4	206	95,9	10.6	230,25	0.76
169.4	210	95.2	10.4	230.44	0.76
161.4	214	94.1	10.2	229.89	0,76
151.8	216	91.7	9.9	227.97	0.74
139.7	223	92.9	9.3	230.36	0.75

Tab. 9

FDE *hood* summary results

Gear	**1**	**2**	**3**
Q @ 0 Pa:	92.3	178.1	323.1
QIEC:	90.7	171.3	315.0
PIEC:	3	11	37
FDEhood:	1.3	6.3	10.9
QBEP:	51.1	109.9	193.5
PBEP:	38	126	198
WBEP:	43.1	61.5	97.4
FDEhood:	10.9		***WL* [W]**
QBEP:	193.5	**LED**	2.4
PBEP:	198	**LED**	5.6
WBEP:	97.4	**Halogen**	70

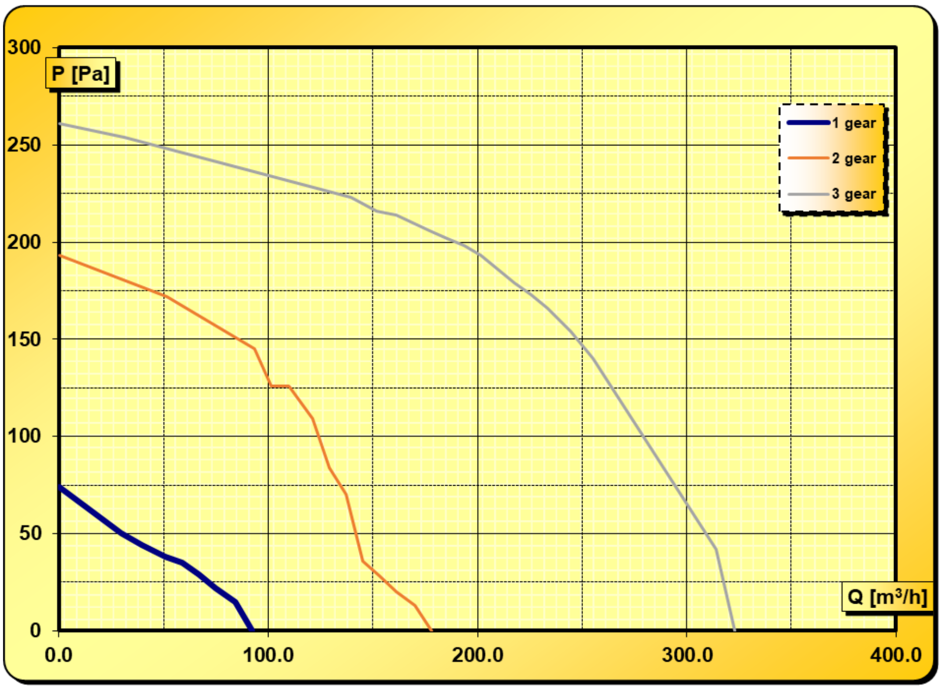

Fig. 4. Pressure as a function of the air flow rate for the 3 gears of the range hood

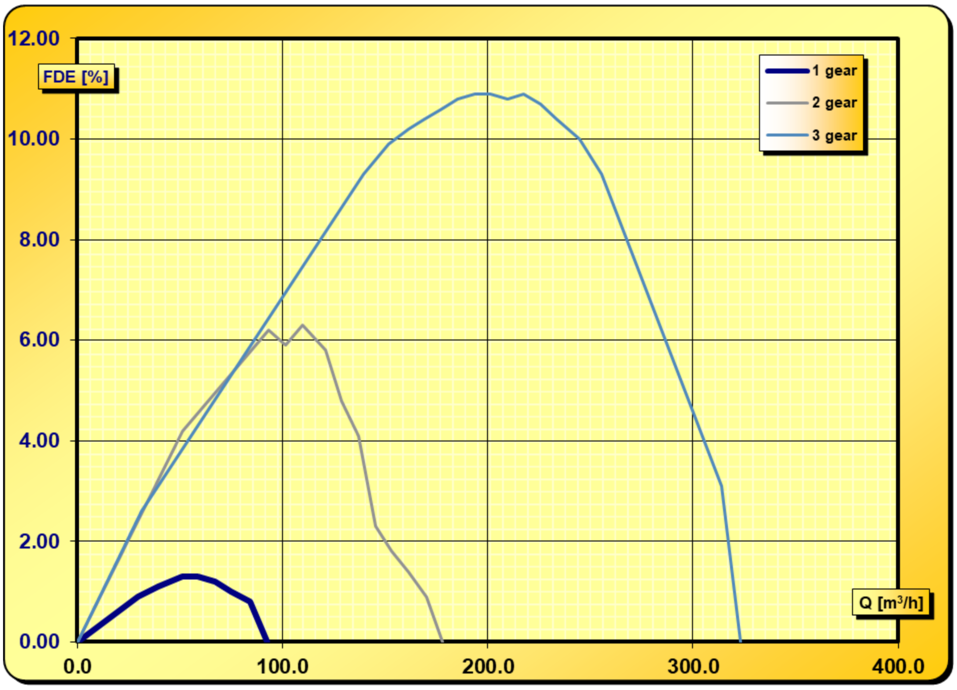

Fig. 5. Fluid dynamic efficiency as a function of air flow rate for the 3 gears of the range hood

5. INNOVATIVE SOLUTIONS REDUCING ENERGY CONSUMPTION OF THE RANGE HOODS

The subject of the patented original invention Pat. 227789 is a range hood with a suction channel to suck the airflow, equipped with an additional system that generates energy [20]. The range hood is equipped with an energy generating system and has a turbine connected with a generator generating direct current energy. Through an energy charging regulator, it is sent to the battery, which is the source for supplying energy to the display and LED lighting of the range hood. In the event of discharging the battery, the display and LED lighting are automatically switched to an electric network with the use of an applied automatic power switch module battery-electric network. The purpose of the applied invention is, apart from air absorption, the generation of electric energy to illuminate the surfaces of the heating plates. The invention contributes to the effective use of generated current of mechanical energy through a generator for the production of electric energy. The applied solution will make the range hood more functional with the use of the work of a turbine to power the generator generating electric energy. Further, it will reduce the energy consumption of the range hood. The range hood according to the invention is presented in Figure 6 and includes: a turbine (1) connected with a generator generating energy (2), a charging regulator (3), and a rechargeable power source (4), whereas, the rechargeable power source (4) is connected with an automatic power switch module (5), supplying energy to the display (6), and the LED lighting (7) of the hood.

Another innovation reducing energy consumption of range hoods that the authors patented in an invention Pat.22826 is a range hood with a suction channel to suck the airflow [21].

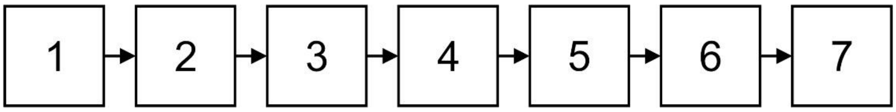

Fig. 6. Block diagram of the electric system of a range hood according to the invention Pat. 227789

It has a remotely controlled height adjustment device equipped with a cut-off system, whereas the height adjustment device has separate circuits powering the motor and lighting. This device is equipped with double carrier cables made of stainless steel, which are also linear energy-saving sources of light. The advantage of the invention is its new functionality of adjustment of its height and the high degree of safety of use resulting from equipping height adjustment devices with a cut-off system that is activated when the hood is lowered too low or when the carrier cables are no longer loaded. Double ceiling-mounted carrier cables prevent rotation of the hood. A positive effect of the invention is an option of adjustment of its height that can be regulated or changed at any moment, for example, allowing efficient cleaning and replacement of the hood filters and energy-saving lighting.

The range hood, according to the invention, is presented in Figure 7 and includes: a height adjustment device (3), remotely controlled using a remote controller (2), equipped with a cut-off system; however, the height adjustment device (3) of the range hood (1), has separate circuits powering the motor and lighting and this device is equipped with double carrier cables made of stainless steel, which is also energy-saving linear sources of light.

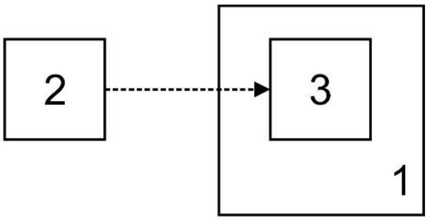

Fig. 7. Block diagram of the electric system of a range hood according to the invention Pat. 22826

In agreement and cooperation with a company producing range hoods, patent solutions presented by the authors are tested under laboratory conditions. A few test models with constructional modifications and patent solutions were selected for the research. The research material is constantly analysed, and solutions of the range hoods are being improved. Upon obtaining comprehensive results of the research and appropriate analyses, the authors wish to publish them and present the impact of the proposed patent solutions on the reduction of energy consumption of the range hoods.

6. CONCLUSIONS

Technological progress enables to remove many onerous consequences resulting from having a range hood, such as excessive noise, complicated control or high energy consumption. Looking for ecological solutions, unique technologies of absorbing cooking vapour aiming at achieving good energy class as a guarantee of lower energy consumption should be applied.

Then, the range hood will remove vapour without raising energy bills economically and ecologically.

Research on FDE_{hood} *(Fluid Dynamic Efficiency)* of the selected range hood was presented in this publication, showing the need for investments in new technologies providing high energy classes. The proposed original patent has the potential for practical application in means of transport equipped with a zone for preparing meals. This research provides many premises and arguments for future constructional solutions of energy management in various branches of transport. Full analysis of the research conducted for test models with patent solutions will provide answers to what their impact on the environment would be in the context of energy consumption and reduction of energy consumption. Subsequently, there is a need to search for solutions to increasing the energy efficiency of range hoods through the application of existing non-proprietary technologies, which may lead to the reduction of the total costs of exploitation of these devices. The results of theoretical analysis, simulation and laboratory research show that the goal set by the authors was achieved.

Nowadays, the industry dictates the directions of research. However, it needs not only scientific research but also their effects, that is, specific new technologies and solutions. In supporting the growth of innovation in science and the industry, research should be conducted collaboratively towards achieving results benefitting both sides.

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