

## CONSTRUCTION OF THE CHOICE FUNCTION OF THE PREFERENCE SOLUTIONS FOR THE PELLET BURNER

*Annotation. Object modeling – the burner with fuel granules (pellets) for heating. It was investigated the effect of the five physical parameters on the three output parameters of the burners. The experimental results are compared with each other, and with the help of expert estimates it was constructed the complete matrix of the binary choice relation. It was constructed the mathematical model of the choice function. As arguments – the values of physical parameters of the compared pairs solutions, as functions – the value 1 or 0 depending on whether a pair physical parameters is preferable.*

*Key words:* choose function, binary relation, mathematical model, expert evaluation.

### Problems formulation

There are considered tubular gas heater [7]. This heaters design is burner, pipe for supplying primary air, pipe for supplying fuel and tubular heater. As fuel could be used different fuels. But the article deals with using biofuels such as pellets. According to the authors it is the most promising and needy research.

Burner design characterized by following components: burner area and effective area for primary air penetration. Heater is certain pipe diameter. In the interval between tubular part and burner gets secondary air. Traction creates by ejector at the tubular heater outlet.

Fig. 1 shows principle tubular gas heater pellets burner block diagram and shows main elements.

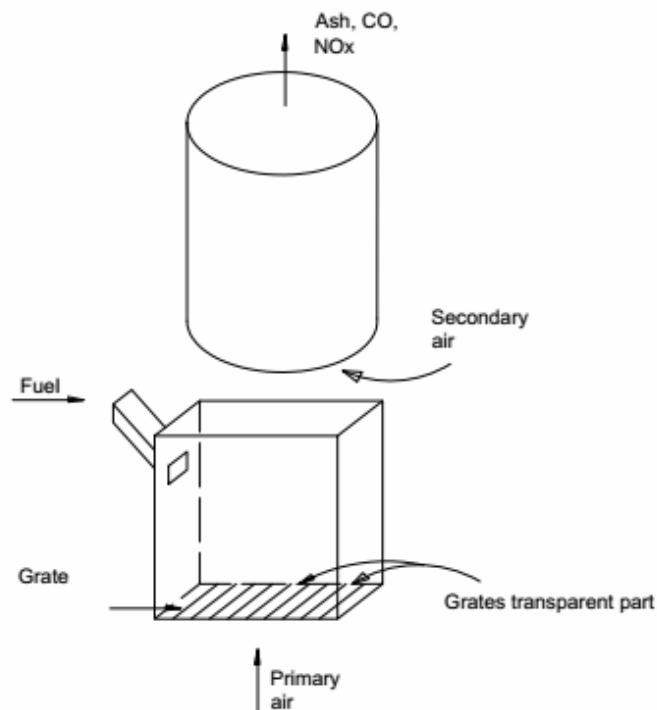


Fig. 1 Tubular heater pellets burner principle block diagram

Tubular heaters design parameters are below:

- Burner area,  $S$ ;
- Useful area for primary air passage,  $S_{fir}$ ;
- Primary air flow,  $L_1$ ;
- Total air flow,  $L_{tot}$ ;
- Burner power,  $W$ .

Also it could be shown criteria by which being heaters work evaluation:

- Ash transfer by the time,  $A$ ;
- Concentration CO at exhaust gases,  $C_{CO}$ ;
- Concentration  $NO_x$  at exhaust gases,  $C_{NO_x}$ .

There are following requirements for parameters that characterize tubular heaters work: for CO it is less than  $130 \text{ mg/m}^3$  and for  $NO_x$  – less than  $250 \text{ mg/m}^3$ . Therefore such tags as CO and  $NO_x$  are shown at tubular heater schematically block diagram. Also such parameter as ash is typical because of strengthened primary air supply creates unintended carrying out ash from the burner. It leads to tube clogging, which degrades heat transfer and reduces tube efficiencytime.

Thus, to the input parameters that characterized tubular heaters working include following: burner characteristic size, pellets using, primary and total air flow. To output parameters include following: ash transfer by the time burner works and CO and NO<sub>x</sub> concentrations in exhaust gases.

There are conducted research and decided to build choise function mathematical model for this heaters. For this experimental data were transformed tubular heater in pair comparison matrix type work.

### **Recently research analysis**

Tubular heaters have been widely used in late twentieth century. They used mostly for industrial facilities autonomous heating systems [9] such as greenhouses [3], workshops. Using these heaters in residential and public buildings is not allowed [1].

There are various heaters construction schemes including air heating systems [8], systems with recirculation, etc.

One of the perspective directions is tubular heater using in building construction [11].

There are various approaches for tubular heaters modeling [2, 4, 10, 14]. But these article problems substantially differ from current.

### **Article aims**

Authors set goal to build full choise function [5, 12]. For accomplishing this aim was built pair comparison table by experimental points. Each of these points represents experimental mode for which were made relevant measurements.

### **Main material**

As researches result were obtained experimental data table. It present in table 1.

Table1

Experimental data converted into dimensionless kind and in relative form from 0 to 1

							max=130	max=250
Nº	S	S пер	L <sub>заг</sub>	L <sub>1</sub>	W	3	C <sub>CO</sub>	C <sub>NOx</sub>
1	0,5	0,572	0,7155	0,440252	0,335	0,175	0,012	0,964
2	0,5	0,572	0,6795	0,430464	0,313	0,240	0,153	0,681
3	0,5	0,572	0,6795	0,397	0,547	0,231	0,001	0,852
4	1	0,643	0,792	0,738	0,18	0,018	0,102	0,845
5	1	0,643	0,8145	0,828	0,32	0,039	0,016	0,674
6	1	0,643	0,855	0,736	0,355	0,458	0,003	0,757
7	1	0,643	0,7785	0,924	0,828	0,233	-	-
8	0,5	0,254	0,8865	0,38	0,26	0,024	-	-
9	0,5	0,245	0,7425	0,484	0,32	0,018	-	-
10	0,5	0,254	0,7515	0,509	0,36	0,010	-	-
11	1	0,287	0,819	0,769	0,3	0,083	-	-
12	1	0,287	0,774	0,872	0,6	0,278	-	-
13	1	0,287	0,742	0,787	0,94	0,202	-	-
14	0,5	0,572	0,723	0,218	0,18	-	0,051	0,431
15	0,5	0,572	0,671	0,134	0,2	-	0,016	0,753
16	0,25	0,084	0,25125	0,134	0,064	0,298	0,063	0,293
17	0,25	0,084	0,21	0,244	0,09	0,583	0,066	0,441
18	0,25	0,084	0,20625	0,26	0,18	0,833	0,164	0,359
19	0,25	0,084	0,188	0,337	0,18	0,583	0,178	0,411
20	0,25	0,084	0,268	0,102	0,047	0,133	0,032	0,48
21	0,25	0,084	0,25125	0,139	0,113	0,408	0,03	0,635
22	0,25	0,084	0,245	0,153	0,1	0,417	0,023	0,691
23	0,25	0,084	0,2275	0,214	0,128	0,300	0,018	0,697
24	0,25	0,084	0,2225	0,14	0,053	0,150	0,018	0,661
25	0,25	0,084	0,208	0,167	0,045	0,058	0,049	0,526

The following table 1 below shows pair comparisons. If the point that compared better comparison point than we get 1. Vice versa we get 0. This method (matrix task) is the best for such problem [6].

Table2

Experimental modes comparison (Column mode compared to line regime,  
if its better than 1, on the contrary – 0)

<b>№</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>12</b>	<b>13</b>	<b>14</b>	<b>15</b>
<b>1</b>	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
<b>2</b>	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1
<b>3</b>	0	0	1	0	0	1	1	1	1	1	1	0	1	0	0
<b>4</b>	0	1	1	1	0	1	0	1	1	1	0	0	0	1	1
<b>5</b>	0	0	1	1	1	1	0	1	1	1	0	0	0	0	0
<b>6</b>	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0
<b>7</b>	0	0	0	1	1	0	1	1	1	1	0	0	1	0	0
<b>8</b>	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0
<b>9</b>	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
<b>10</b>	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<b>11</b>	0	0	0	1	1	0	1	1	1	1	1	0	1	0	1
<b>12</b>	0	0	1	1	1	0	1	1	1	1	1	1	1	0	1
<b>13</b>	0	0	0	1	1	0	0	1	1	1	0	0	1	0	1
<b>14</b>	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1
<b>15</b>	0	0	1	0	1	1	1	1	1	1	0	0	0	0	1
<b>16</b>	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1
<b>17</b>	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1
<b>18</b>	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1
<b>19</b>	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1
<b>20</b>	0	0	1	0	1	1	1	1	1	1	1	1	1	0	1
<b>21</b>	0	0	1	0	1	1	1	1	1	1	1	1	1	0	1
<b>22</b>	0	0	1	0	1	1	1	1	1	1	1	1	1	0	1
<b>23</b>	0	0	1	0	1	1	1	1	1	1	1	1	1	0	1
<b>24</b>	0	0	1	0	1	1	1	1	1	1	1	1	1	0	1
<b>25</b>	0	0	1	0	1	1	0	1	1	1	1	1	1	0	1

Experimental modes comparison (Column mode compared to line regime,  
if its better than 1, on the contrary – 0)

<b>№</b>	<b>16</b>	<b>17</b>	<b>18</b>	<b>19</b>	<b>20</b>	<b>21</b>	<b>22</b>	<b>23</b>	<b>24</b>	<b>25</b>
<b>1</b>	1	0	0	0	1	1	1	1	1	1
<b>2</b>	1	1	0	0	1	1	1	1	1	1
<b>3</b>	0	0	0	0	0	0	0	0	0	0
<b>4</b>	1	1	1	1	1	1	1	1	1	1
<b>5</b>	0	0	0	0	0	0	0	0	0	0
<b>6</b>	0	0	0	0	0	0	0	0	0	0
<b>7</b>	0	0	0	0	0	0	0	0	0	1
<b>8</b>	0	0	0	0	0	0	0	0	0	0
<b>9</b>	0	0	0	0	0	0	0	0	0	0
<b>10</b>	0	0	0	0	0	0	0	0	0	0
<b>11</b>	0	0	0	0	0	0	0	0	0	0
<b>12</b>	0	0	0	0	0	0	0	0	0	0
<b>13</b>	0	0	0	0	0	0	0	0	0	0
<b>14</b>	0	0	0	0	1	1	1	1	1	1
<b>15</b>	0	0	0	0	0	0	0	0	0	0
<b>16</b>	1	0	0	0	1	1	1	1	1	1
<b>17</b>	1	1	0	0	1	1	1	1	1	1
<b>18</b>	1	1	1	0	1	1	1	1	1	1
<b>19</b>	1	1	1	1	1	1	1	1	1	1
<b>20</b>	0	0	0	0	1	0	1	1	1	0
<b>21</b>	0	0	0	0	1	1	1	1	1	0
<b>22</b>	0	0	0	0	0	0	1	1	1	0
<b>23</b>	0	0	0	0	0	0	0	1	0	1
<b>24</b>	0	0	0	0	0	0	0	1	1	0
<b>25</b>	0	0	0	0	0	0	0	1	1	1

Formally choise function [13] can be written in following form:

$$C_R(X) = \{x \in X / \forall y \in X, xRy\} \quad (1)$$

where:

$C_R(X)$  - choise function;

x – single presentation;

X – incoming presents amount;

R – binarychoise relation.

Table 1 at fact is matrix setting choise function R but only on conducted experimental set.

It is interest to expand choise function (extrapolation) on investigation area. It is applicable different approaches. In this article proposed for specify choise used indicator choise function form as:

$$Y(x^{(1)}, x^{(2)}) = \text{int}\left(\frac{Z(a_1, a_2, \dots, a_6, x_1^{(1)}, x_2^{(1)}, \dots, x_5^{(1)})}{Z(a_7, a_8, \dots, a_{11}, x_1^{(2)}, x_2^{(2)}, \dots, x_5^{(2)})}\right) \quad (2)$$

$$Y \in \{0, 1\}$$

де:

$x_1^{(1)}, x_2^{(1)}, \dots, x_5^{(1)}$  – parameters values at the point 1;

$x_1^{(2)}, x_2^{(2)}, \dots, x_5^{(2)}$  – parameters values at the point 2;

$a_1, a_2, \dots, a_{11}$  – choise function parameters.

Thus if  $Y=1$  than value  $x^{(1)}$  preferable than  $x^{(2)}$ .

Thus if  $Y=0$  than value  $x^{(2)}$  preferable than  $x^{(1)}$ .

Recovery choise indicator function (2) task formulated as follows. It is necessary to find unknown parameters  $a_1, a_2, \dots, a_{11}$  meaning such that the indicator choise function value at experimental data (table 1) points best correspond to comparison table 2.

Specific depending form (2) may be different. There are studied as linear and nonlinear dependings. For example for construction dependence:

$$Z^1(a_1, a_2, \dots, a_6, x_1^{(1)}, x_2^{(1)}, \dots, x_5^{(1)}) = a_1 + a_2 x_1^{(1)} + a_3 x_2^{(1)} + a_4 x_3^{(1)} + a_5 x_4^{(1)} x_5^{(1)} + a_6 x_5^{(1)} x_6^{(1)}$$

and:

$$Z^2(a_7, a_8, \dots, a_{11}, x_1^{(2)}, x_2^{(2)}, \dots, x_5^{(2)}) = a_6 + a_7 x_1^{(2)} + a_8 x_2^{(2)} + a_9 x_3^{(2)} + a_{10} x_4^{(2)} x_5^{(2)} + a_{11} x_5^{(2)} x_6^{(2)}$$

As values deviation minimizing results for indicator function (2) from table 2 comparison matrix meanings obtained parameters that presented at table 3:

Table 3

Choise function models parameters

№	a <sub>1</sub>	a <sub>2</sub>	a <sub>3</sub>	a <sub>4</sub>	a <sub>5</sub>	a <sub>6</sub>	a <sub>7</sub>	a <sub>8</sub>	a <sub>9</sub>	a <sub>10</sub>	a <sub>11</sub>
Koef	-28.27	-3.46	20.65	-5.07	2.07	0.56	-0.37	42.93	15.83	-0.15	-15.87

Thus choise function identification achieved percent is 78% .

### Conclusions

There are choice function's construction's sequence are sets. There are posed point comparison results that characterized tubular gas heater's condition with expert's evaluation using. Also posed output functions comparisons by which can be characterize improving tubular gas heater's performance or vice versa.

### REFERENCES

1. Горелки газовые промышленные. Общие технические требования : ГОСТ 21204-97 / Межгос. совет по стандартизации, метрологии и сертификации. – Изд. офиц. ; [введ. 1998-07-01 ; взамен ГОСТ 21204-83]. – Минск, 1998. – 35 с.:табл. – (Межгосударственный стандарт).
2. Дудкин К. В. Математическое моделирование трубчатых газовых нагревателей для безопасного нагрева воды в объеме со свободной поверхностью / К. В. Дудкин, В. В. Ткачева, Ю. В. Бобырь // Строительство, материаловедение, машиностроение : сб. науч. тр. / Приднепр. гос. акад. стр-ва и архитектуры"; под общ.ред. В. И. Больщакова. – Днепропетровск, 2011. – Вып. 62 : Безопасность жизнедеятельности 2011. – С. 166–170.
3. Дудкин К. В. Воздушно-водяная система теплоснабжения теплиц с трубчатыми газовыми нагревателями / Дудкин К. В., Ткачова В. В., Данишевский В. В. // Восточно-европейский журнал передовых технологий. – 2013. – Т. 3, № 8(63). – С. 57–60.
4. Іродов В. Ф. Регуляризація часткових описів при еволюційному пошуку рішень на основі самоорганізації / Іродов В. Ф., Барсук Р. В. // Строительство, материаловедение, машиностроение : сб. науч. тр. / Приднепр. гос. академии стр-ва и архитектуры; под общ. ред. В. И. Больщакова. – Днепропетровск, 2015. – Вып. 84. – С. 111–116.
5. Литvakov B. M. Аппроксимация функций выбора. / Литvakov B. M. // Автоматика и телемеханика. – 1984. – Вып. 9. – С. 138-146. – Режим доступа:  
<http://www.mathnet.ru/links/6c3faa9f1fbe0e4abf8580f75055ba32/at4847.pdf>
6. Теория выбора и принятия решений / Макаров И. М., Виноградская Т. М., Рубчинский А. А., Соколов В. Б. – Москва: Наука, 1982. – 328 с.
7. Пристрій для променевого обігріву та нагрівання повітря : пат. 61594 Україна (UA), МПК F24D 10/00, F24C 15/00 / Іродов В. Ф., Осетянська Д. Є., Хацкевич Ю. В.; заявник та власник Придніпр. акад. буд-ва і архітектури. – № u201015435; заявл. 20.12.2010 ;опубл. 25.07.2011, Бюл. № 14

**5 (106) 2016 «Системные технологии»**

---

8. Пристрій для променевого обігріву та нагрівання повітря : пат. 92674 Україна (UA), МПК F24D 10/00, F24D 15/00, F24C 15/00 / винахідники та власники : Барсук Р. В., Іродов В. Ф., ЧорноЯван А. А. – № и201403524 ; заявл. 05.04.2014 ; опубл. 26.08.2014, Бюл. № 16.
9. Система повітряно-променевого опалення : пат. 83475 Україна (UA), МПКF24D 10/00,F24D 15/00 / винахідники та власники : Дудкін К. В., Іродов В. Ф., Ткачова В. В., Чорноморець Г. Я. – № и 201304161 ; заявл. 03.04.2013 ; опубл. 10.09.2013, Бюл. № 17.
- 10.Ткачова В. В. Індуктивне моделювання трубчастого газового нагрівача та пальника на пелетах / Ткачова В. В., Барсук Р. В. // Строительство, материаловедение, машиностроение : сб. науч. тр. / Приднепр. гос. акад. стр-ва и архитектуры ; подобщ. ред. В. И. Больщакова. – Днепропетровск, 2014. – Вып. 78 : Компьютерные системы и информационные технологии в образовании, науке и управлении. – С. 275–281.
- 11.Чорноморець Г. Я. Техніко-економічне обґрунтування використання трубчастих нагрівачів розташованих у будівельних конструкціях / Чорноморець Г. Я. // Строительство, материаловедение, машиностроение : сб. науч. тр. / Приднепр. гос. акад. стр-ва и архитектуры ; подобщ. ред. В. И. Больщакова. – Днепропетровск. – Вып. 76 : Энергетика, экология, компьютерные технологии в строительстве. – С. 293–298.
- 12.Юдин Д. Б. Вычислительные методы теории принятия решений / Юдин Д. Б. – Москва: Наука, 1989.–320 с.
- 13.Salama A. S. Accurate topological measures for rough sets / Salama A. S. // International Journal of advanced research in artificial intelligence. – 2015. –Vol. 4, iss. 4. – P. 31–37. – Available at:  
[https://thesai.org/Downloads/IJARAI/Volume4No4/Paper\\_5-Accurate\\_Topological\\_Measures\\_for\\_Rough\\_Sets.pdf](https://thesai.org/Downloads/IJARAI/Volume4No4/Paper_5-Accurate_Topological_Measures_for_Rough_Sets.pdf)
- 14.Taler D. Mathematical modeling of tube heat exchanger with complex-flower arrangement / DawidTaler, MarcinTrojan, JanTaler // Chemical and Process Engineering. – 2011. –Vol. 32, iss. 1. – P. 7-19. – Available at:  
[http://www.degruyter.com/dg/view/article.fullcontentlink:pdfeventlink/\\$002fj\\$002fcpe.2011.32.issue-1\\$002fv10176-011-0001-y\\$002fv10176-011-0001-y.pdf/v10176-011-0001-y.pdf?t:ac=j\\$002fcpe.2011.32.issue-1\\$002fv10176-011-0001-y\\$002fv10176-011-0001-y.xml](http://www.degruyter.com/dg/view/article.fullcontentlink:pdfeventlink/$002fj$002fcpe.2011.32.issue-1$002fv10176-011-0001-y$002fv10176-011-0001-y.pdf/v10176-011-0001-y.pdf?t:ac=j$002fcpe.2011.32.issue-1$002fv10176-011-0001-y$002fv10176-011-0001-y.xml)