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RESEARCH REGARDING ENERGETICAL CONSUMPTION AT WHEAT MASH DISTILLATION WITH PREHEATING AND AUTOMATION WORK PROCESS

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Abstract

Distillation process requires high energy input and this aspect increase price of the raw spirit. In consequence it is necessary to develop the research in order to: decrease energy input necessary for distillation-rectification process; increase product quality in accordance with national and European norms; increase the work capacity and decrease the distillation period. These things can be reached through to introduce new parameter control and automated on regulating system, which has influence distillation process. The new system require a high performance temperature, pressure, flow rate and concentration sensors with a computer and a data acquisition system.
Keywords: *alcohol industry, raw materials, starch, fermentation, processing wheat, distillation, ethanol, stillage, energy consumption*

Introduction

The energy input analyzed to process, storage and transport of food product showed high energy consumption. In consequence it is necessary to develop the research in order to:

- decrease energy input necessary in distillation-rectification process;
- increase product quality in order to comply national and European norms;
- increase work capacity and decrease distillation period;

These things can be touch through to introduce new parameter control and automated regulating system, which has influence distillation process.

Distillation-rectification energetic input plants is different of installation to installation, starting at type of plant (continuous or discontinuous), steam consumption in *kg/h*, ethanol value in alcoholic degree, plant productivity in *hl/24* hour etc (Muntean, 2002b).

To analyze the process parameter of different type of plants is necessary to show next performance category: energetically, report at steam feeding necessary to obtain 1 kg of ethanol of mash (Senn, 2002); organic, regarding final product to be pure and concentrate and not have substance like methanol, ether and other wrong components; quality, regarding condition to be reached in accordance with national and international standards (Muntean, 2002b).

Experimental researches follow *energetically optimization* of *distillation process at wheat mash fermentation with preheating mash and automation work process* have next **objective**: to establish maximum temperature level in different distillation column section and optimal steam and mash flow to obtain a high ethanol (Senn, 2002); to analyze constructive, functional and process factors at energetically process parameter; to establish specific steam consumption to produce 1 kg of ethanol with various steam and mash feeding flow; to establish temperature influence at mash feeding plant (Quadt, 1989). Mash is obtained from wheat at Hohenheim University. Mash pH is 4…4.4 and alcoholic content is 7…7.4 % (Muntean, 2002b).

During the distillation, was used various type of technological process (changing mash and steam flow and mash feeding temperature). Simultaneously was checked the steam consumption, temperature inside of plant in different section, pressure, ethanol flow and value, preheating water temperature outlet condenser. The experiments are during in the same time interval, doing 24 experimental distillation processes in 4 work mode (Muntean, 2002b):

- mode 1 – column function is without preheating mash and without automation process;
- mode 2 - column function is with preheating mash and without automation process;
- mode 3 - column function is without preheating mash and with automation process;
- mode 4 - column function is with preheating mash and with automation process.

Experimental

Experimental research is following general method which is shown in figure 1 (Muntean, 2002a).

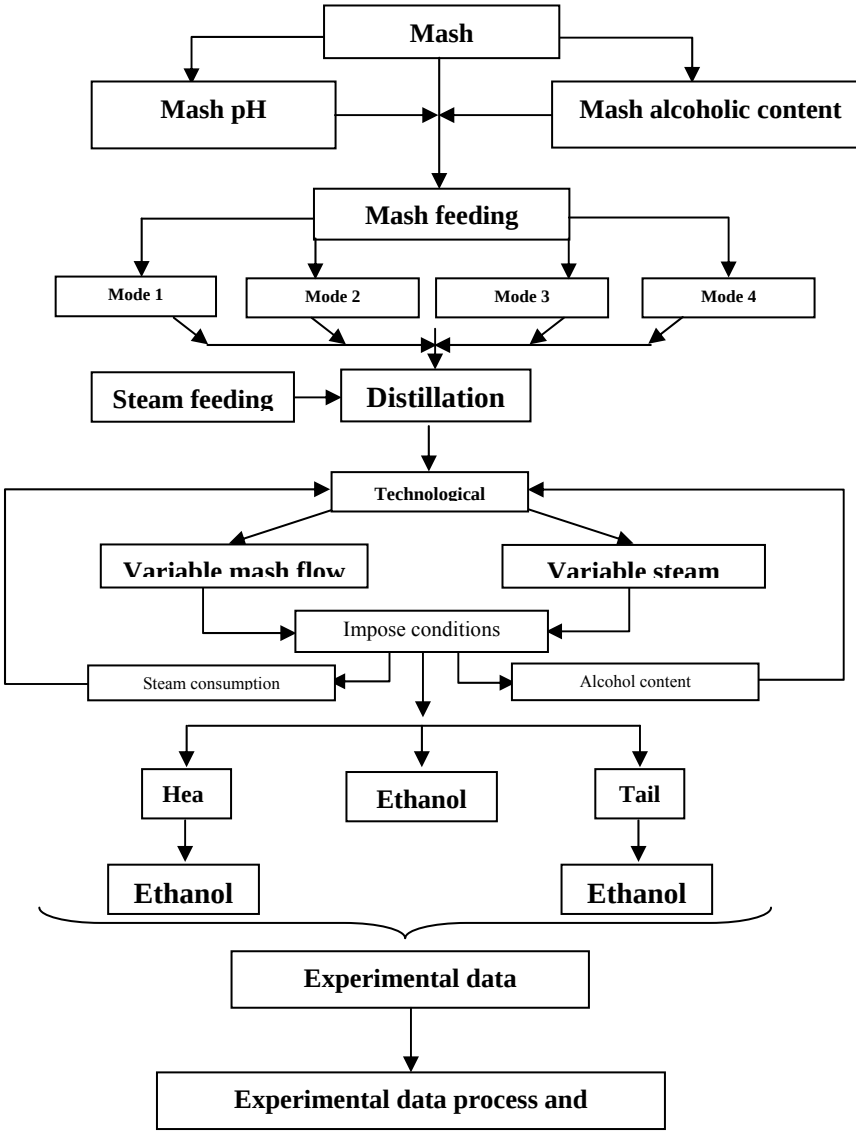

Fig. 1.General method of experimental

Experimental data was collected to process plant computer and in order to study results was used a PentiumIII/1300 MHz laptop used in experimental researches. To process data and to make graphical representation are used Microsoft Excel programmed (Muntean, 2003).

Plant principal characteristics are shown in table 1.

Table 1. Principal characteristics distillation of J.K.Goppingen plant type D – 73002

Characteristics	Value
Distillation column height, m	5
Rectification column height, m	1.5
Mash dephlegmator height, m	1.5
Column diameter, m	0.8
Plates number in distillation section	14
Plates number in rectification section	5
Steam consumption at 1.2...1.4 pressure bar in kg/h	30...40
Weight, kg	2800
Productivity, hl/24 h	20...30
Steam temperature Injection, °C	104...108

Column (figure 2) is a continuous distillation-rectification column and components are:
1-mash feed pump; *2*-distillation column; *3*-rectification column; *4*-preheating-dephlegmator; *5*-condenser; *6*-ethanol control apparatus; *7*-ethanol tank; *8*-stillage pump; *9*-steam feed; *10*-cold water feed; *11*-hot water evacuate who are used in preheating; *12*- evacuate water out of dephlegmator.

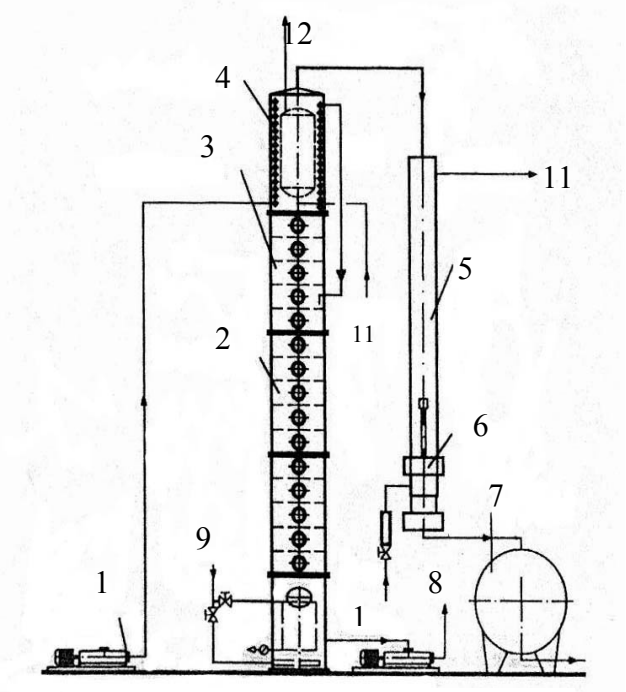

Fig. 2. Distillation column D – 73002

Results and Discussions

From every type of model are made six try counts. Table 2 shows steam consumptions in four work-modes, finally are obtaining 96 % alcoholic degree ethanol. The experiments are in the same time interval. Table 3 shown ethanol quantity made from mash in every work-mode. Table 4 shown mash quantity used in work-modes.

Table 2. Steam consumption (kg) in work- mode

Experience number	Work mode 1	Work mode 2	Work mode 3	Work mode 4
	Steam quantity (kg)			
1	168	163	165	157
2	165	147	160	146
3	165	151	159	148
4	174	163	166	159
5	175	160	167	158
6	160	150	159	147

Table 3. Total ethanol quantity (liters) obtained in work mode

Experience number	Work mode 1	Work mode 2	Work mode 3	Work mode 4
	Ethanol quantity (liters)			
1	223	242	232	246
2	210	236	226	241
3	217	228	225	239
4	206	225	219	232
5	212	239	223	244
6	218	229	227	235

Table 4. Mash quantity (liters) used in work-mode

Experience number	Work mode 1	Work mode 2	Work mode 3	Work mode 4
	Mash quantity (liters)			
1	6120	6320	6220	6277
2	6170	6310	6240	6265
3	5950	6270	6070	6181
4	6035	6350	6150	6228
5	5975	6225	6095	6133
6	6083	6290	6190	6246

Table 5 shows ethanol quantity obtains from 1 mash liter. Table 6 shows steam consumption from 1 ethanol liter. Table 7 shows steam

consumption (kg) from 1 mash liter, and table 8 shows mash consumption from 1 ethanol liter. The same data are graphically presented in figures 3-6.

Table 5. Ethanol quantity obtain from 1 mash liter

Experience number	Work mode 1	Work mode 2	Work mode 3	Work mode 4
	Ethanol quantity (l)			
1	0.03602	0.04350	0.03950	0.04427
2	0.03622	0.04385	0.03897	0.04563
3	0.02723	0.04397	0.03339	0.04498
4	0.03593	0.04443	0.04144	0.04623
5	0.03887	0.04333	0.04123	0.04712
6	0.03532	0.04364	0.03864	0.04436

Table 6. Steam consumption from 1 ethanol liter

Experience number	Work mode 1	Work mode 2	Work mode 3	Work mode 4
	Steam quantity (l)			
1	0.73	0.58	0.63	0.55
2	0.66	0.59	0.61	0.54
3	0.76	0.58	0.64	0.52
4	0.79	0.57	0.70	0.53
5	0.83	0.56	0.76	0.55
6	0.82	0.60	0.74	0.54

Table 7. Steam consumption (kg) from 1 mash liter

Experience number	Work mode 1	Work mode 2	Work mode 3	Work mode 4
	Steam quantity (l)			
1	0.026	0.025	0.024	0.023
2	0.027	0.026	0.023	0.021
3	0.027	0.025	0.024	0.022
4	0.028	0.024	0.025	0.024
5	0.029	0.025	0.025	0.023
6	0.027	0.024	0.024	0.022

Table 8. Mash consumption from 1 ethanol liter

Experience number	Work mode 1	Work mode 2	Work mode 3	Work mode 4
	Mash quantity (l)			
1	27.75	23.98	25.28	22.15
2	27.60	22.36	23.36	21.06
3	29.48	23.53	24.65	20.55
4	27.46	21.75	23.58	20.10
5	26.95	23.07	22.27	21.20
6	28.66	22.91	23.81	20.03

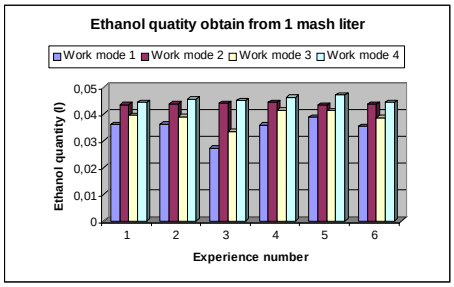

Fig. 3. Ethanol quantity obtained

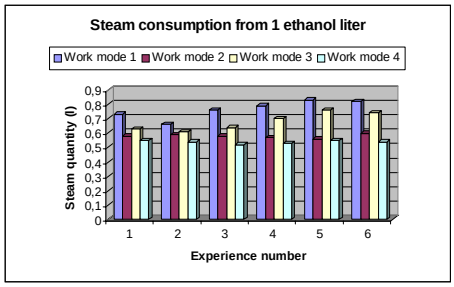

Fig. 4. Steam consumption (ethanol)

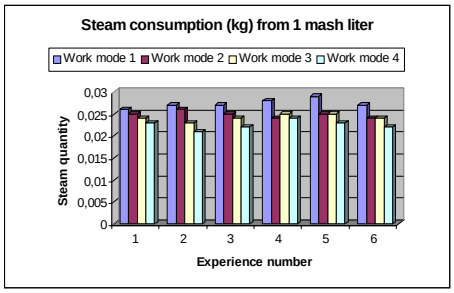

Fig. 5. Steam consumption (mash)

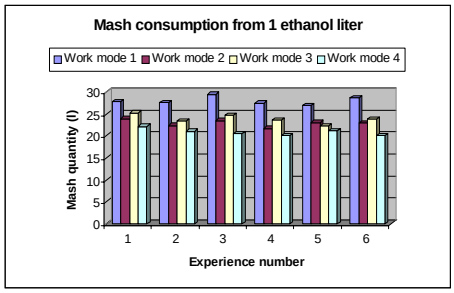

Fig. 6. Mash consumption (ethanol)

From tables 2-8 and figures 3-6 can be observed that:

- Steam consumption is lower in work-mode 2 with 0.93...0.97, in work-mode 3 with 0.95...0.98 and in work-mode 4 with 0.88...0.93 than work-mode 1.
- Ethanol quantities obtain form mash is higher in work-mode 2 with 1.05...1.12, in work-mode 3 with 1.04...1.07 and in work-mode 4 with 1.10...1.15 comparative to work-mode 1. Mash quantity used in work-mode 2 is higher with 1.03...1.05 than work-mode 1.
- Ethanol (liter) obtains from one mash liter is: in work-mode 2 higher with 1.16...1.23, in work-mode 3 higher with 1.10...1.23 and in work-mode 4 higher with 1.22...1.28, than work-mode 1.
- Steam consumption to obtain 1 liter ethanol is: in work-mode 2 is lower with 0.89...0.72, in work-mode 3 is lower with 0.84...0.92 and in work-mode 4 is lower with 0.65...0.75 than mode 1.

- Mash consumption to obtain 1 liter ethanol is lower in mode 2 with 0.86...0.79, lower in mode 3 with 0.82...0.91 and lower in mode 4 with 0.69...0.79 than mode 1.

Conclusions

There is no doubt that work-mode 4 is better to use than work-modes 1, 2 or 3 but if can be observe preheating mash decrease energetically consumption, steam, mash and automation process are obtain a higher quantity of ethanol.

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