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THE APPLICATION OF AN APPARATUS FOR TESTING THE QUALITY OF CONDENSATE FROM EVAPORATORS IN SUGAR FACTORIES **)

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A new appratus for testing the quality of condensate operated in the sugar factory during whole campaign. That analyser protects steam boilers against damage caused by presence of sugar in water feeding the boilers.

In modern sugar factories heat control based on high efficiency steam boilers fed with condensate obtained from evaporation is essential. Continuous quality control of condensate formed during evaporation protects steam boilers against traces of sugar [1-4].

For several years studies were carried out in the Department of Sugar Technology and later in the Institute of Food Chemical Technology, Technical University of Łódź on the methods of quality control of condensate used to feed steam boilers [5-8]. The main principles of the design were presented to the Scientific Committee of the CITS, Łódź, 1973 [8, 9].

The condensate analyser consists of a rectifying column in which the process of volatile and non-volatile compounds separation takes place. Condensate is directly introduced into the analyser about 1 l/h. During the experiments a correlation was found between the content of non-volatile compounds, e.g. potassium salts and the content of sugar in the condensate [6, 8, 9]; the respective ratio being 1:80. Owing to this, by

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determining the salt content, the content of sugar in condensate from evaporation plant can be determined with high accuracy. Results are recorded on tape. Impulses from the analyser control the valves.

The distillate from the rectifying column is condensed and cooled. The content in volatile compounds — mainly ammonia [10] — is then determined. The presence of ammonia in the condensate from the evaporation plant indicates that the decomposition process of amides has not been completed during the main liming process. If the purfication of juice occurs according to the parameters assumed before, then on the basis of the analyser indication conclusions may be drawn as to the quality of processed beets and especially as to the content of harmful nitrogen. In the case of disturbances in the decomposition of amides in the main limer, ammonia concentration in condensate immediately rises. Measurement results are recorded on tape. This makes the process of juice purfication control easier and to some extent makes the estimation of raw material quality possible.

THE ANALYSER'S WORK

The appratus for testing the quality of condensate is of a simple construction and easy to operate (Fig. 1).

Fig. 2 shows the scheme of the apparatus work [9]. The rectifying column 1 is joined at its lower part to column 2 supplied with a heater 3 the outlet of which is a thin pipe 4. This pipe is directed through a cooler 8 into the inductometer 5, by means of which the concentration of non-volatile compounds proportional to the concentration of trace amounts of sugar is measured. In the upper part of the rectifying column 1 is situated the pipe 6 by which the condensate is led in. Energetic heating of the lower part of the column 2 causes evaporation of the major part of condensate, including all the volatile compounds. The vapour flows trough pipe 7 and condenses in cooler 8. The outflowing condensate containing volatile compounds is introduced, after cooling, into the inductometer 9 which indicates the concentration of volatile compounds, mainly ammonia.

The apparatus is regulated in such a way that 80% of condensate is evaporated in the rectifying column and 20% flows through pipe 4 and the cooler into the inductometer 5. Thus the sensitivity of the inductometer 5 readings is five several fold increased into the inductometer 9. The ratio of concensate volume out flowing from pipes 4 and 7 allows to see whether the analyser is properly adjusted. The results of the inductometer measurements 5 and 9 are recorded on the tape of the recorder 10 in the form of two curves. Inductometer 5 sends direct

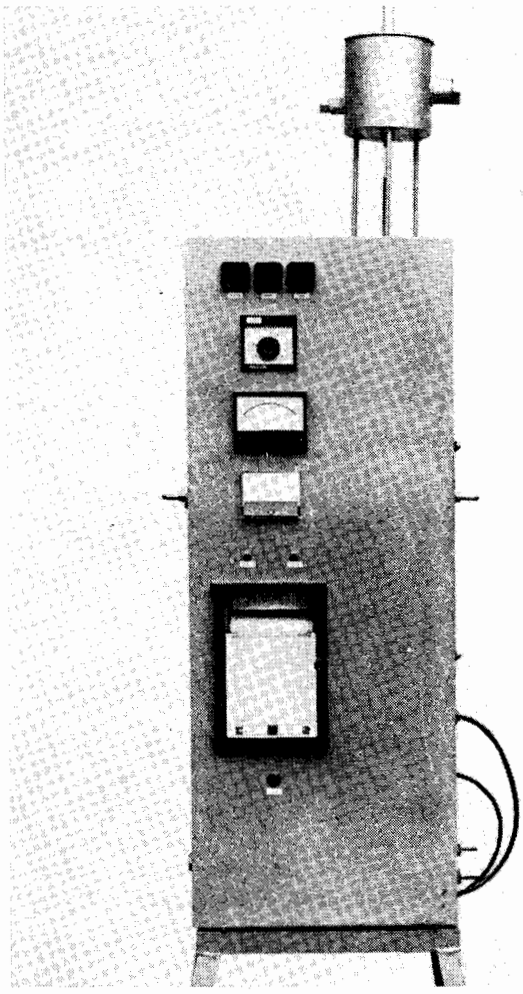

Fig. 1. Condensate analyser

impulses to close or to open valves on pipes leading to the feed water tank in the boiler house.

Examination of the method of sugar determination.

Even small amounts of sugar passing into vapour in case of juice foaming get the condensate and may be the reason for steam boiler damage.

Sensitivity of the method of sugar determination in condensate was studied on the basis of the inductometer 5 readings (Table 1). Therefore, thin juice of concentration 15° Bx in an amount of 0.1-20 ml was added to 100 l of pure condensate flowing through the analyser. After adding 0.5 ml of juice the sugar concentration in condensate is 0.75 ppm and the swing of the pointer is 3%. Reaction with α-naphthol is negative. Only after the addition of 1.0 ml of juice i.e. if concentration of sugar

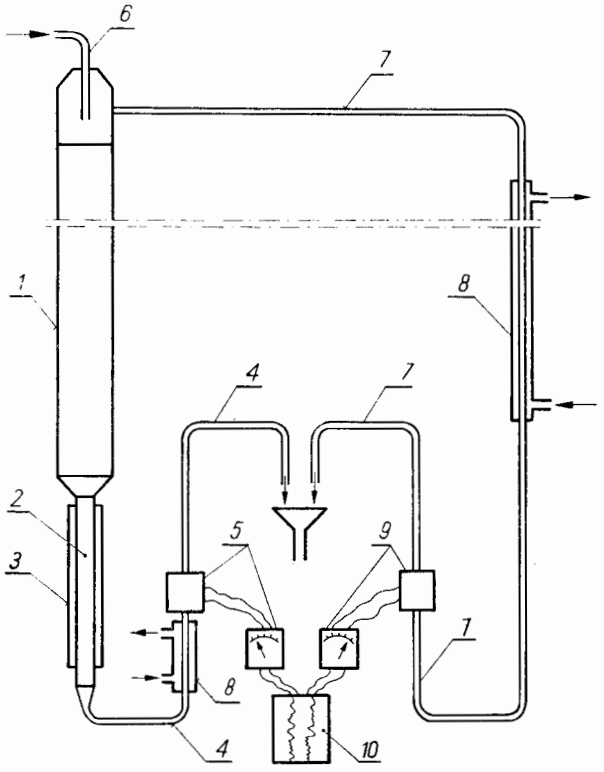

Fig. 2. Scheme of the condensate analyser; 1 — rectifying column, 2-3 — column with heated coat, 4-6-7 — pipes inductometers for the determination of trace amounts of salt proportional to the trace amount of sugar, 8 — cooler, 9 — inductometer for the determination of volatile compounds concentration, 10 — recorder

in the solution was 1.5 ppm, the inductometer readings exceeded 5% of the scale. In such a solution a ightly pink ring after the reaction with α-naphthol could be observed. Two mililiters of juice having been added, which corresponds to 3 ppm of sugar, the inductometer readings reach 10% the scale. Reaction with α-naphthol shows the pink ring.

Swing of the pointer within 4-5% of the scale makes that the impulse is sent to the respective valves. Inflow of condensate to the boiler feed water tank is closed and at the same time the valve disposing condensate to the hot water tank is opened.

In practice, after juice has been entrained, which makes the valves switch and produces a simultaneous alarm signal, the entrainment of juice usually stops. In such a case, after 5-10 minutes, traces of sugar are washed out from the calandria and from pipes. The inductometer readings fall below 3% of the scale and the analyser generates an impulse which closes the inflow of condensate to the hot water tank,

and simultaneously opens the inflow to the boiler feed water tank. The system automatically returns to the previous state, the intervention of the operator being unnecessary.

Table 1. Sensitivity of sugar determination method

Composition of solution tested Thin juice of a concentration of 15° Bx was added to 100 dm^3 of distilled water cm^3	Concentration of sugar in the solution ppm	Instrument readings %	Reaction with α-naphthol
0.0	0.00	0	absence of reaction
0.1	0.15	1	absence of reaction
0.5	0.75	3	absence of reaction
1.0	1.5	6	poorly visible ring
2.0	3.0	10	visible pink ring
5.0	7.5	20	clearly visible pink ring
10.0	15.0	35	intensely pink ring
20.0	30.0	50	vider ring

AMMONIA DETERMINATION IN CONDENSATE

Basing on the inductometer readings the content of volatile compounds can be determined, and also the ammonia content of condensate can be defined. The condensate analyser operated in the sugar factory during the whole compaign. The different figures show the results of the inductometer readings recorded on tape during a five hour period.

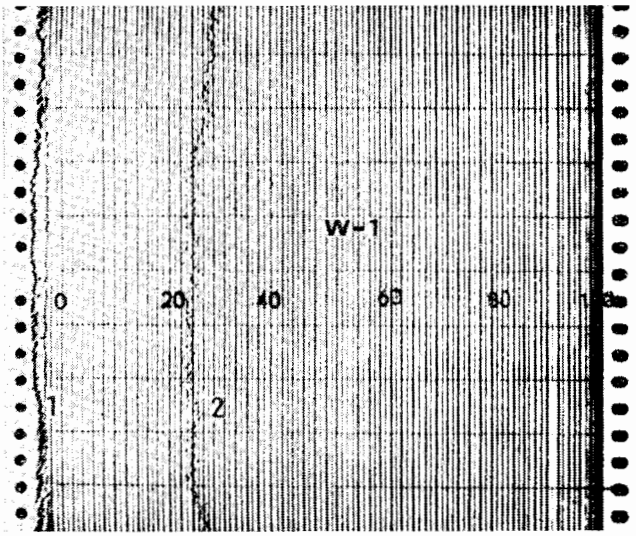

Fig. 3. Readings of the recorder — juice with a moderate amount of nitrogen

Fig. 3 presents a section of the recorder tape during processing of sugar beets of a moderate nitrogen content. Curve number 2 corresponds to the ammonia content of condensate from the second effect of the evaporator, and curve number 1 indicates the content of salt. As it is seen, both values were maintained at a constant level. Fig. 4 shows the section of the recorder tape corresponding to the period when beets contained slightly more nitrogen. The analyser showed more ammonia in condensate.

In Fig. 5 an evident increase of ammonia content in condensate may

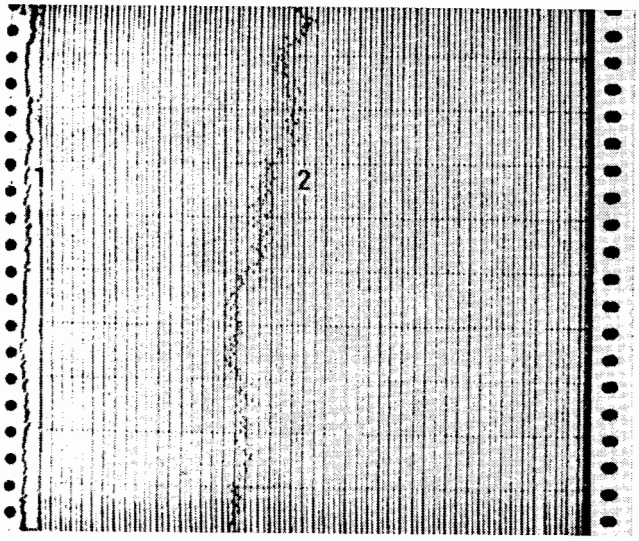

Fig. 4. Readings of the recorder — juice with a slightly higher content of nitrogen

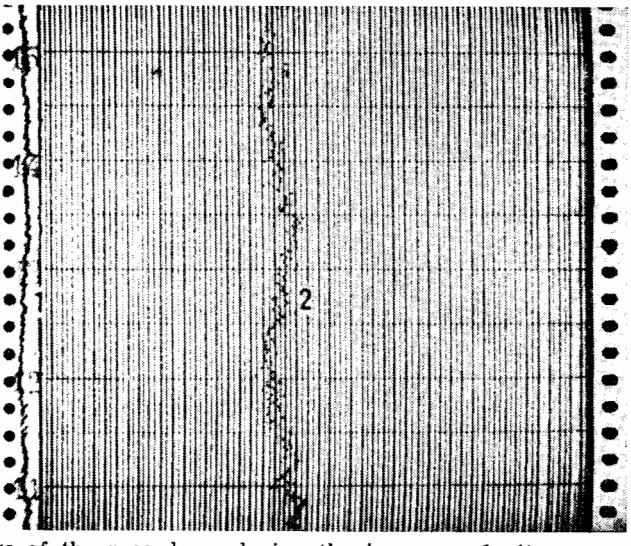

Fig. 5. Readings of the recorder — during the increase of nitrogen content in juice

be observed. In the second part of the 5-hour period the nitrogen content was higher in the juice than in the first half of the period.

As it has been found basing on the inductometer readings the quality of sugar beets under treatment can be determined. The readings are unambiguous only when the purfication process of juice occurs in appropriate technological conditions, also during the main liming process proper alkalinity and temperature of juice are preserved as well as the retention time in the liming tank. If optimum conditions are not provided during the main liming process disturbances in the purification of juice occur.

Fig. 6 presents a section of the tape on which significant changes of the ammonia content of condensate had been registered. For example,

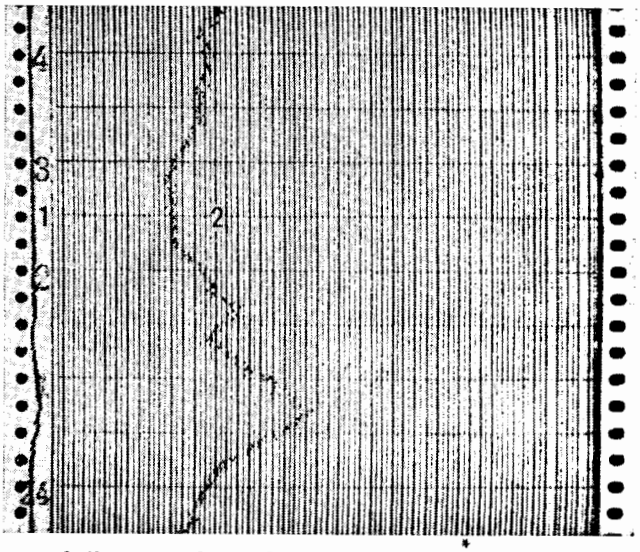

Fig. 6. Readings of the recorder — during variations in nitrogen content in juice

in the 2nd hour of the period under observation, there is a temporary but significant increase of the ammonia content of condensate. This was caused by the drop in juice temperature before the main liming. The obtained juice is characterised by thermolability during thickening [11, 12]. Also, e.g. mild laming may cause considerable increase in the ammonia content of condensate. Recording of the inductometer readings makes the control of the purfication process easier, as well as the estimation of quality thin juice of introduced into the evaporation plant.

Salt content readings on all the four graphs correspond to a position close to zero, i.e. entrainment of juice droplets into vapours in the periods under observation did not occur.

Laboratory determination of the ammonia content in condensate from

each effect of the evaporation plant showed significant differences. Absolute values are exemplified in Table 2.

In case of a low content of nitrogen in sugar beets, harmful nitrogen in particular, the ammonia content in the condensate ranges from 5 to 7 mval/l. If beets contain large amounts of harmful nitrogen — differences of 8-12 mval/l or even more are observed. The ammonia content of condensate depends, as it is known, also on the temperature of juice in juice in each apparatus of the evaporation plant, on the quality of beets and on the purfication method of the juice.

Table 2. Ammonia content in the condensate in particular effects of the evaporation plant

Effect	Ammonia concentration in the condensate			
	October mg/dm³	November mg/dm³	October mval/dm³	November mval/dm³
II	148	180	8.7	10.6
III	137	162	8.0	9.5
IV	105	120	6.1	7.0

Observations carried out in some sugar factories which used apparatus for testing the quality of condensate from the evaporation plant indicate that analysers make the work easier and protect steam boilers against damage caused by the penetration of sugar in to the water feeding the boilers.

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ZASTOSOWANIE APARATU DO BADANIA JAKOŚCI SKROPLIN Z WYPARKI CUKROWNICZEJ

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Streszczenie

Stała kontrola jakości skroplin z wyparki zabezpiecza kotły parowe przed dostaniem się śladów cukru. W Politechnice Łódzkiej opracowano aparat, który wykrywa ślady cukru w skroplinach, a także wykrywa związki lotne, zawierające głównie amoniak. Wyniki są rejestrowane w postaci oddzielnych krzywych.

W przypadku stwierdzenia śladów cukru — analizator powoduje zamknięcie dopływu zanieczyszczonych skroplin do kotłów parowych. Po kilku minutach, gdy w skroplinach nie ma już śladów cukru, analizator ponownie otwiera dopływ czystych skroplin do kotłów parowych. Czułość wskazań analizatora jest większa niż czułość metody wykrywania śladów cukru za pomocą α-naftolu.

Na podstawie krzywej kreślonej przez rejestrator, przedstawiającej zmiany zawartości amoniaku, można wnioskować o jakości procesu oczyszczania soku, a także o zawartości azotu w burakach i w soku.

W pracy podano cztery wycinki z taśmy rejestratora. Na podstawie jednej krzywej, widać że skropliny nie zawierały śladów cukru. Druga krzywa wskazuje zmiany zawartości amoniaku powodowane przerabianiem buraków o różnej jakości, a także zakłóceniem procesu oczyszczania soku. Podano również wyniki ilościowego oznaczania amoniaku w skroplinach z kolejnych działów wyparki.