EKOR
Limited Liability Company
Research & Engineering Enterprise

The system for continuous monitoring of the water mass fraction in the ammonium nitrate melts

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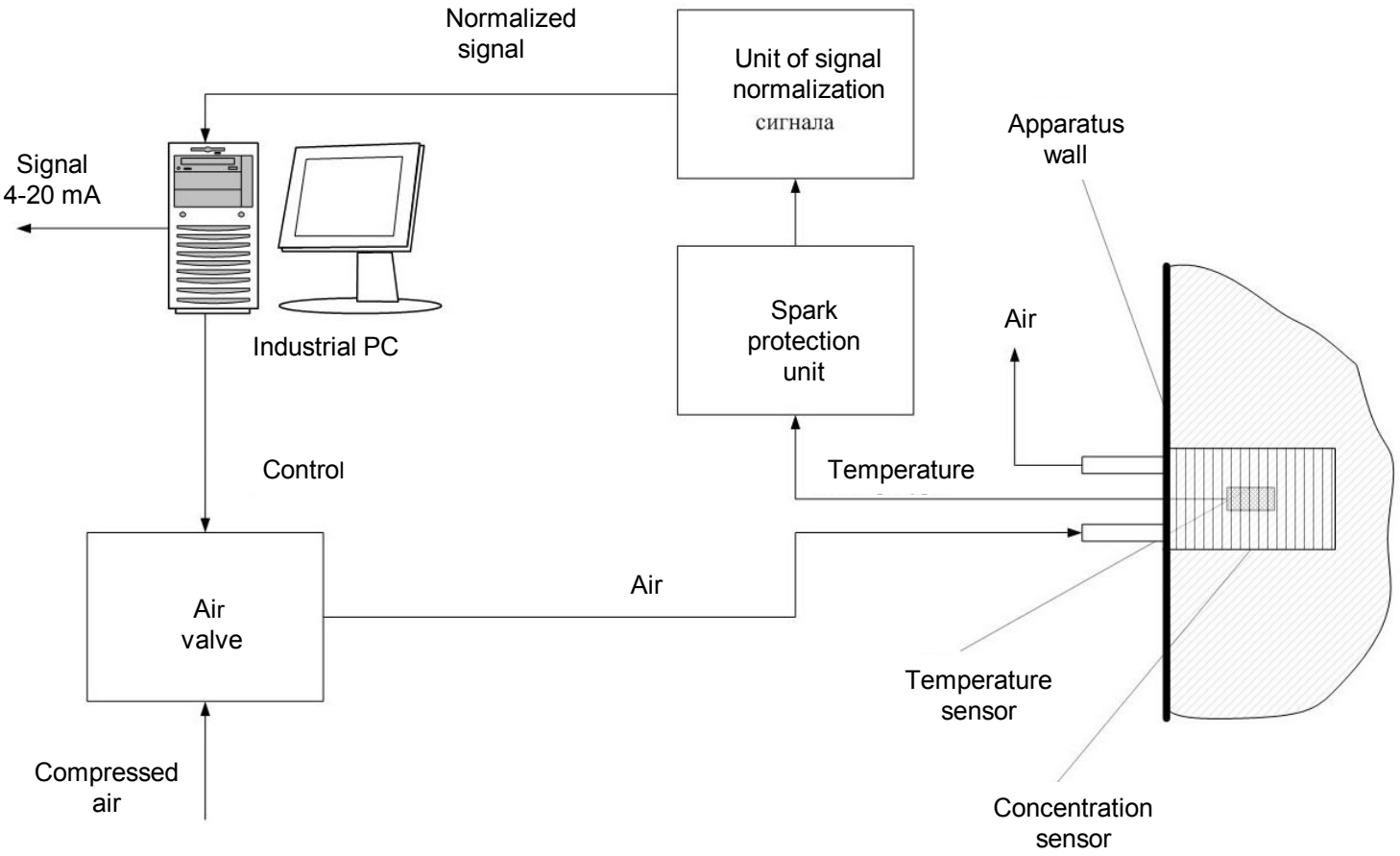
ISO 9001:2008

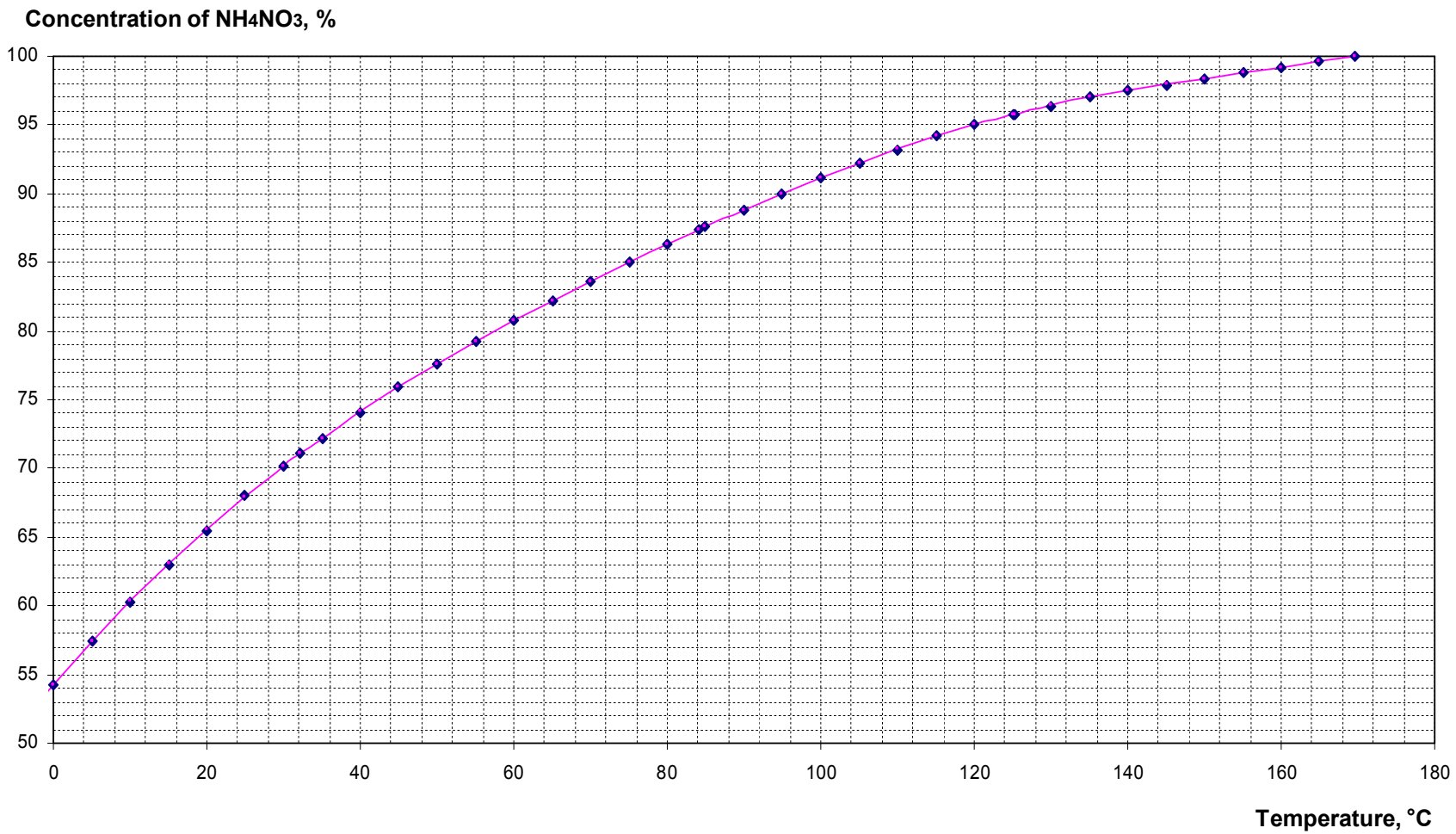
BUREAU VERITAS Certification

The system for continuous monitoring of the water mass fraction in the ammonium nitrate melts (for one channel of concentration measuring) consists of:

- concentration sensor;
- spark protection unit;
- unit of signal normalization;
- valve of refrigerant supply;
- industrial PC with input-output boards.

The system for continuous monitoring of the water mass fraction in the ammonium nitrate melts





Dependence between the temperature of crystallization of melt and the water content in it is about 1,4°C for 0,1% weight of water – is using for concentration determination.

Principle of the system

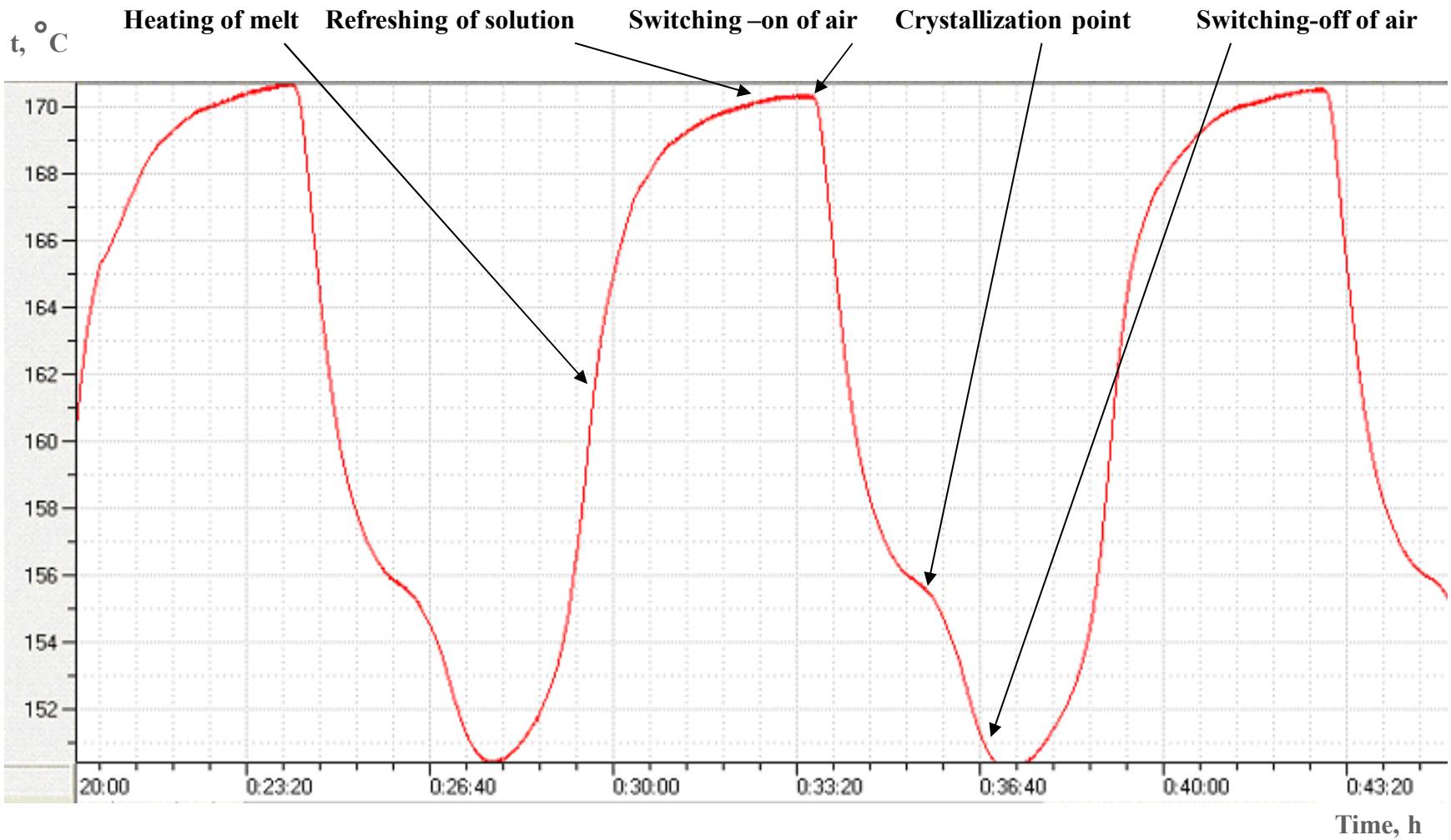
Method of determination of the water mass fraction consists in :

- supplying of refrigerant to the concentration sensor and measuring the temperature inside the sensor during cooling and melt crystallization;
- analysis of the measured dependence “temperature – time” in the “sliding window”, crystallization temperature definition;
- calculation of the water mass fraction in the ammonium nitrate melt.

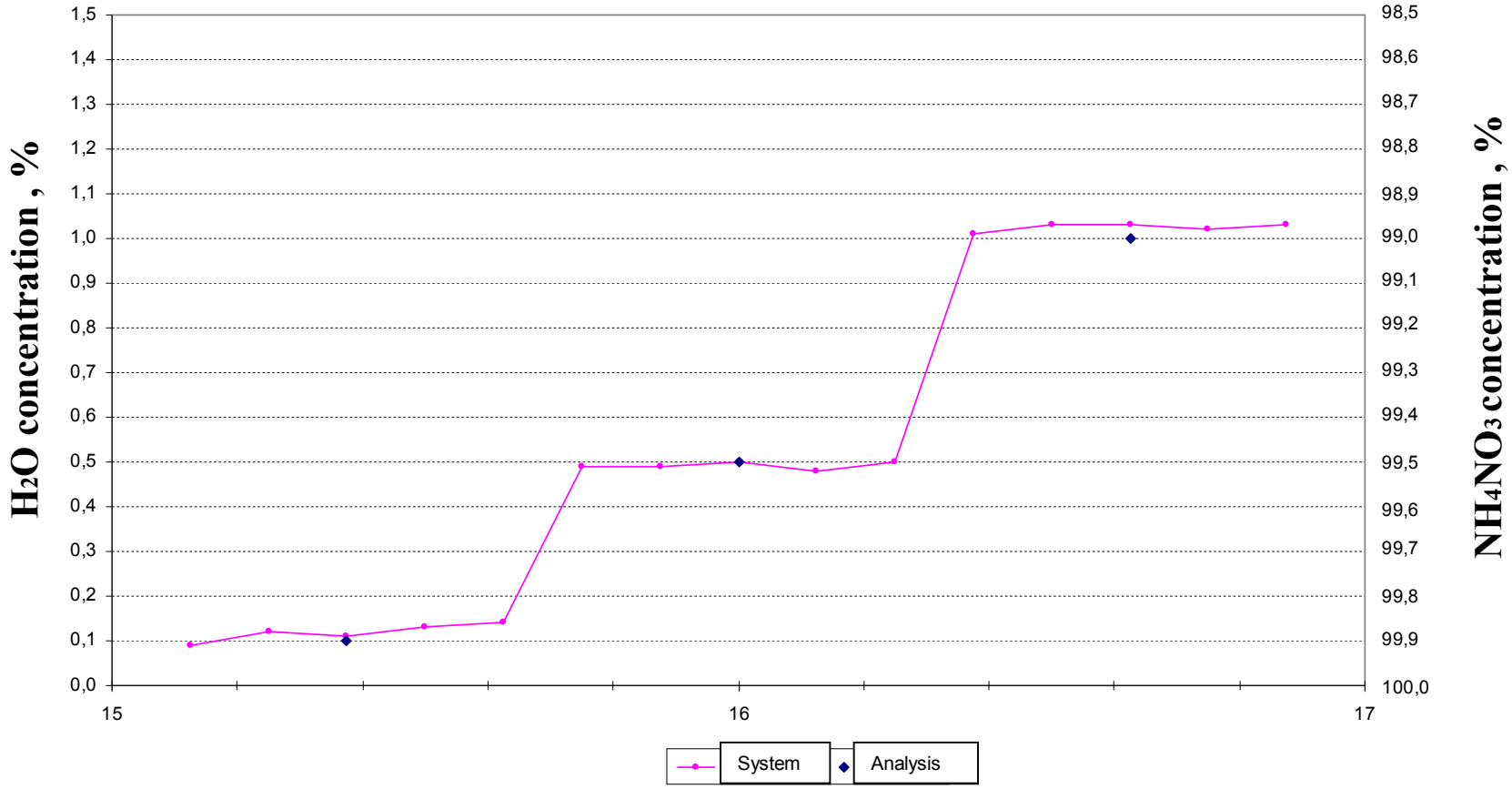
After determining of the crystallization temperature supply of the refrigerant stops, the environment inside the concentration sensor renews and the cycle repeats.

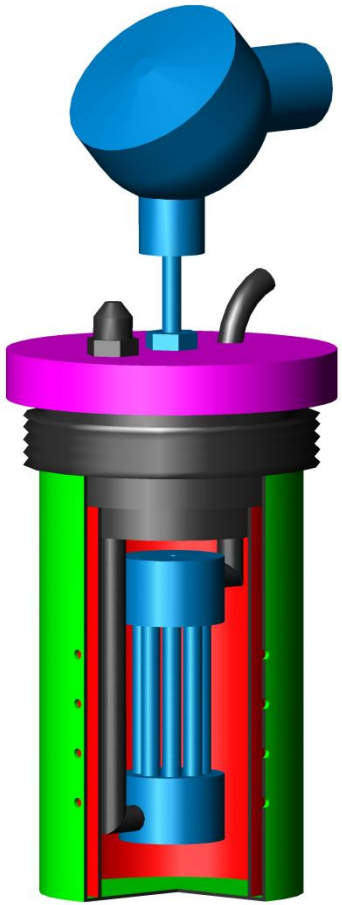
Time of cycle is about 10 min.

Temperature change of melt in the concentration sensor



Changes in the water mass fraction in the ammonium nitrate melt





- The design of concentration sensor provides :
  - even cooling and ammonium nitrate melt crystallization in a closed space;
  - minimal cycle time of the crystallization temperature determination.

- Feature of the temperature sensor is the minimal response time.

Software

- controls the measurement process
- displays the measured process parameters as trends and numeric values;
- allows to view the process history.

Metrological characteristics

Given value of the mass fraction of water $X_{истэ}$, %	Measured value of the mass fraction of water X_i, %	Average measured value of the mass fraction of water $X_{ср}$, %	Standard deviation S, %	Random component of the absolute error $\Delta_{случ.}$, %	The systematic component of absolute error $\Delta_{с.}$, %	Absolute measurement error Δ, %
0,10	0,09	0,12	0,019	0,053	0,018	0,071
	0,12					
	0,12					
	0,12					
	0,14					
1,00	1,01	1,02	0,009	0,024	0,024	0,048
	1,03					
	1,03					
	1,02					
	1,03					
0,50	0,49	0,49	0,008	0,023	0,008	0,031
	0,49					
	0,50					
	0,48					
	0,50					

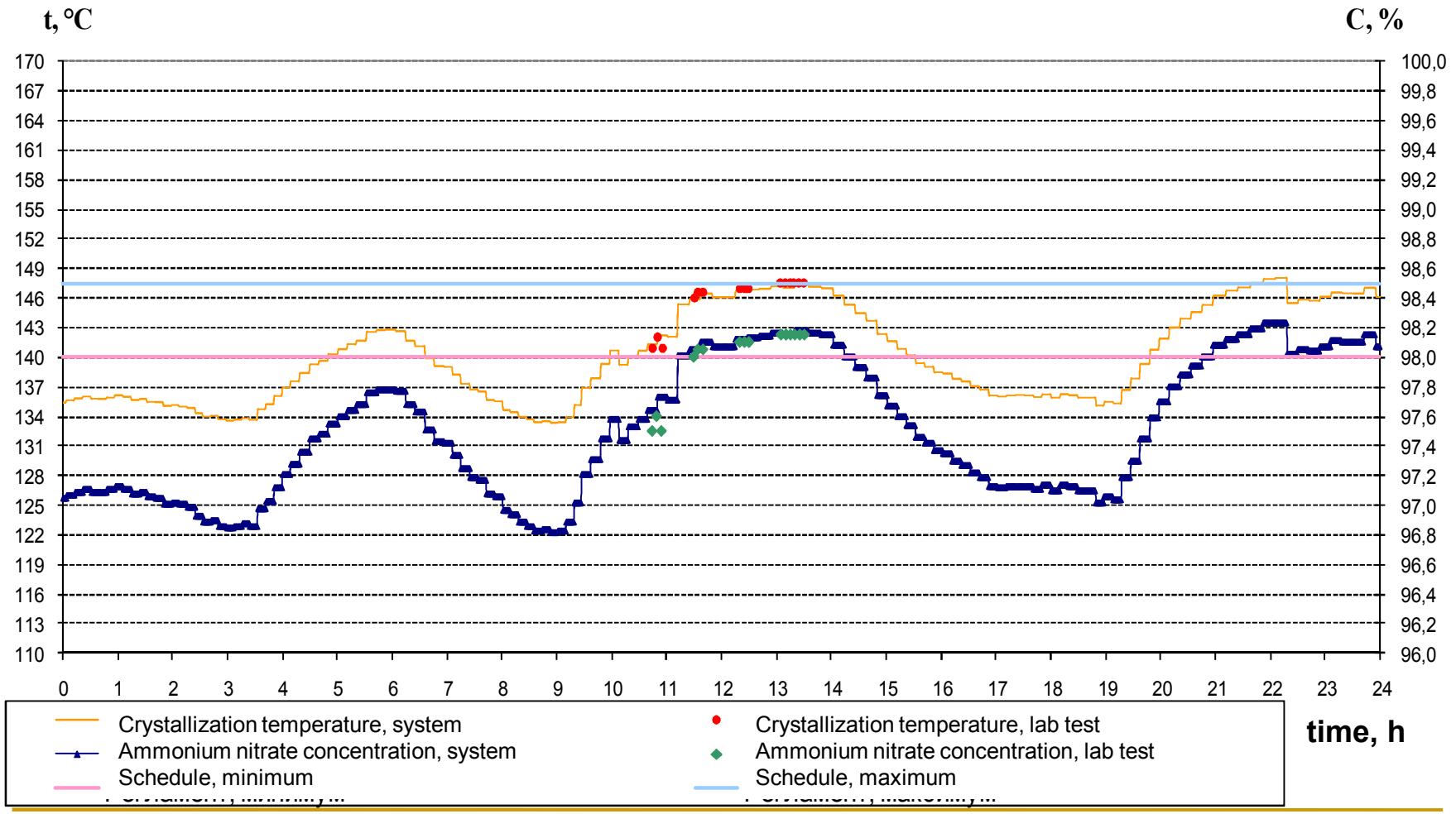
Metrological characteristics (5-15% of water)

Given value of the mass fraction of water $X_{истэ}$, %	Measured value of the mass fraction of water X_i, %	Average measured value of the mass fraction of water $X_{ср}$, %	Standard deviation S, %	Random component of the absolute error $\Delta_{случ.}$, %	The systematic component of absolute error $\Delta_{с.}$, %	Absolute measurement error Δ , %
5,00	4,99	4,94	0,061	0,263	0,060	0,323
	4,99					
	4,84					
10,00	9,49	9,52	0,032	0,140	0483	0,624
	9,57					
	9,49					
15,00	14,39	0,49	0,144	0,618	0,843	1,461
	14,02					
	14,06					

Testing of the system for continuous monitoring of the water mass fraction in the ammonium nitrate melts

- system was tested in the ammonium nitrate manufacture of JSC “Severodonetsk Azot Association”;
- at the same time sampling was carried out, and in accordance with the "Methodology for measuring of ammonium nitrate mass fraction in the melt by the crystallization temperature" № МУ-38 was determined the concentration of the melt;
- tests showed good convergence of measurements.

Changes in the ammonium nitrate mass fraction in the melt pos.602/1



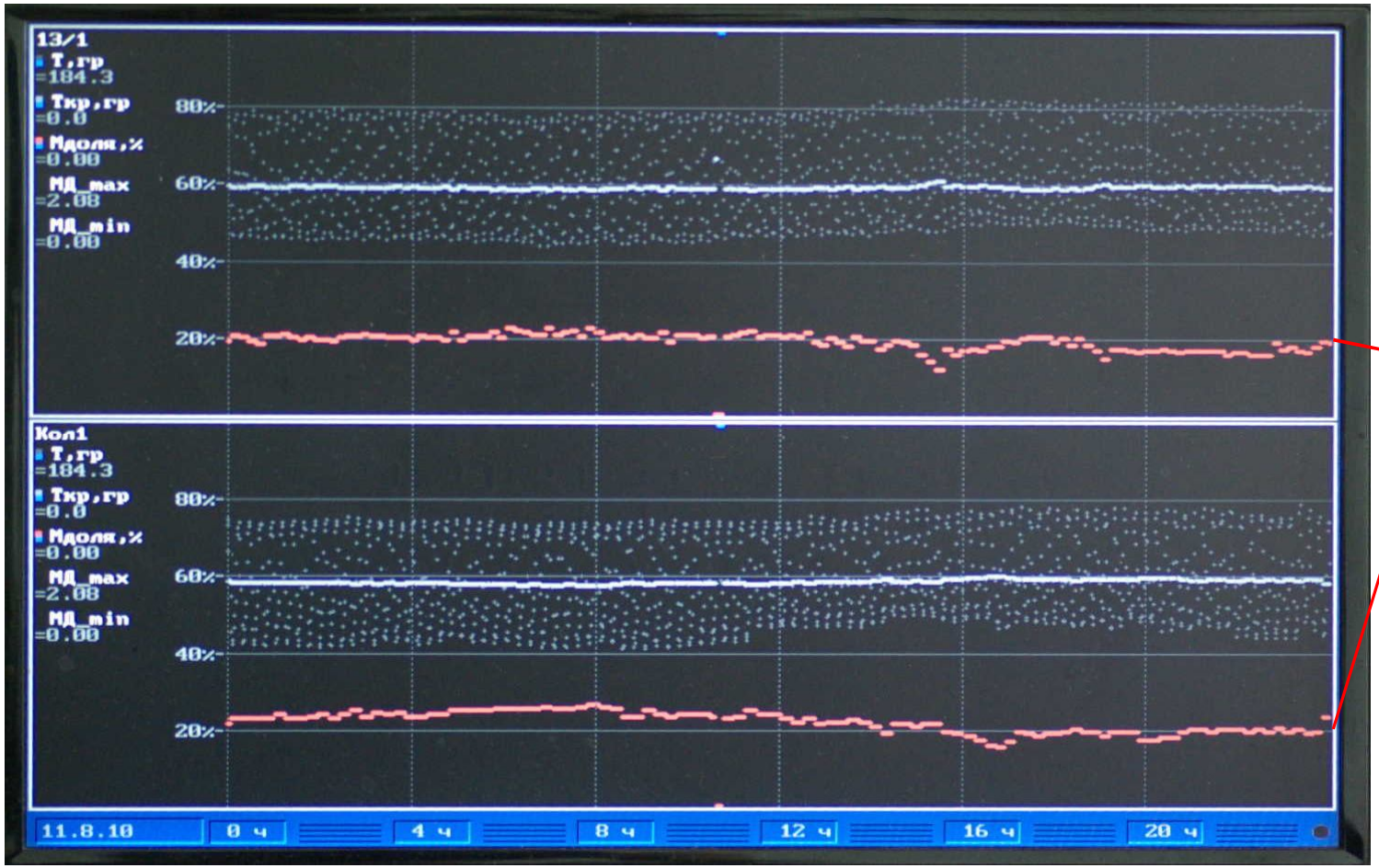
View of the instrument part of system

The control system of water mass fraction in the ammonium nitrate melt is introduced and successfully operated on JSC “Azot” (Cherkassy, Ukraine) and PJSC “Concern “Stirol” (Gorlovka, Ukraine).

Operation of the system for continuous monitoring of the water mass fraction in the ammonium nitrate melts in industrial conditions

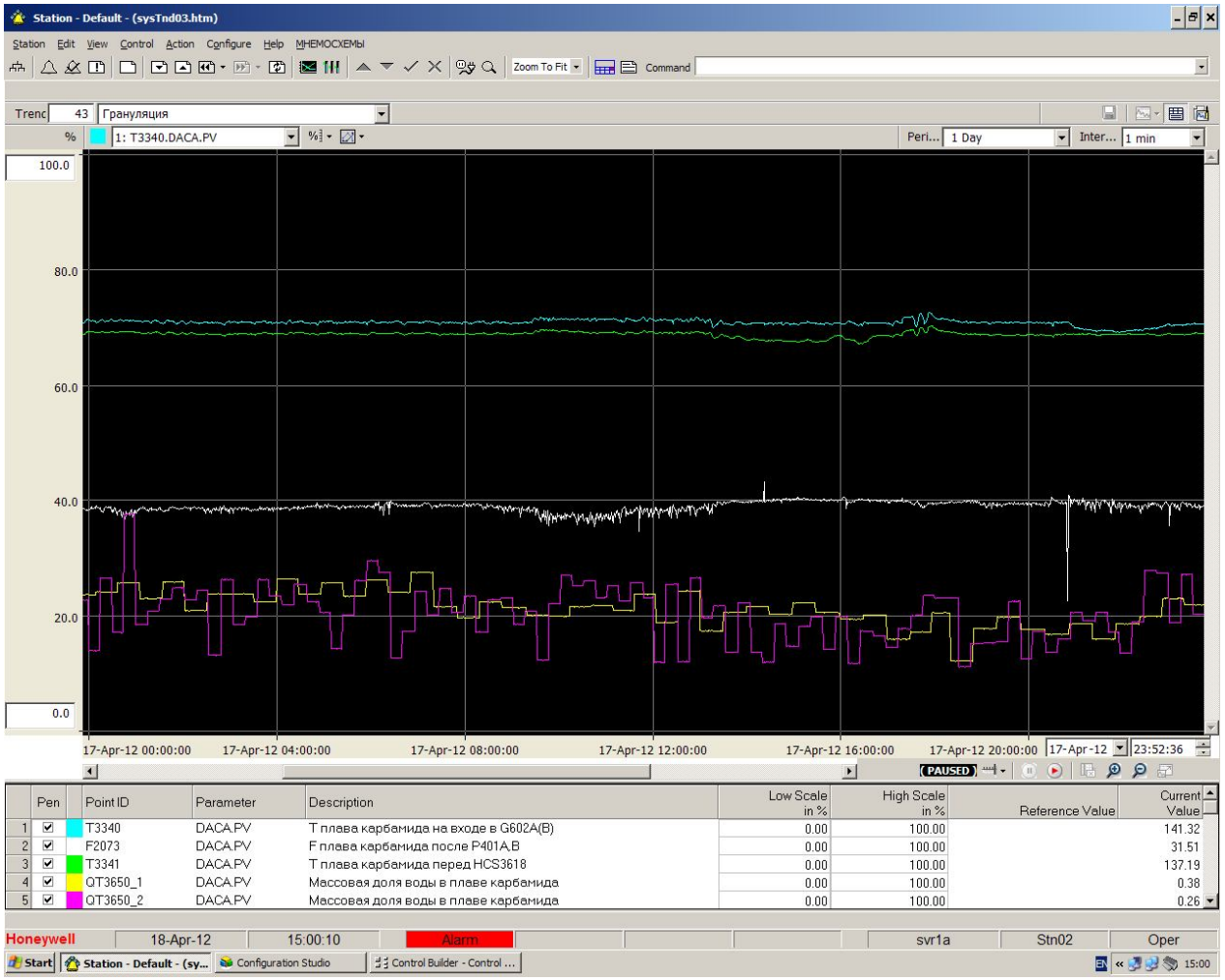
- system includes six monitoring points and controls the mass fraction of water in the melt of ammonium nitrate after the evaporation stage before granulation in the range of 0,1-2% of water;
- system is also used to control the solutions for making of liquid ammonia fertilizer in the range of 8-10% of water.

Graphical screen of the system in viewing mode "for a day" in the manufacture M-9 at the JSC “Azot“, Cherkassy (for two monitoring points)



Mass fraction of the water

Graphic window of operator's workplace



- Measurement data of the water mass fraction is issued as a signal of 4÷20 mA to the current APCS.

The proposed system allows to :

- control the water mass fraction in the technological ammonium nitrate solutions after the neutralization stage and during the entire process;
- control the final product quality(to reduce the number of defects);
- reduce the energy consumption for evaporation;
- complete or replace the labor consuming and subjective laboratory analysis with automatic measurement directly in the ammonium nitrate melt.

Calculation of the economic effect

- **By reducing the steam consumption(E_1)**
  $E_1 = W \cdot \Delta C \cdot M \cdot P_1$ = 101192 UAH/year, or **20240 USD/year,**

W = 1,3ton – amount of steam, required for evaporation of 1 ton of water from the melt of ammonium nitrate in the range 93,0÷99,8%;

ΔC = 0,002 – difference(from99,8to99,6%)in the amount of evaporated water in a ton of ammonium nitrate by more accurate maintenance of the concentration;

M = 400000ton/year – amount of produced ammonium nitrate;

P_1 = 97,3UAH/ton –steam price.

- **By increasing the amount of produced commercial ammonium nitrate (E_2)**
  $E_2 = \Delta C \cdot M \cdot P_2$ =640000 UAH/year, or **128000 USD/year,**

P_2 = 800UAH/ton –ammonium nitrate price.

- **The total economic effect (E) of introduction of the system of continuous monitoring of the mass fraction of water in the melt of ammonium nitrate :**

  $E = E_1 + E_2$ = 741192 UAH / year, or **148240 USD/year.**

Delivery of the system includes :

- system completing;
- supervision of installation of sensors;
- installation of sensors, instrument part of the system;
- system adjustment;
- delivery of technical description and operating instructions;
- training of operating staff;
- carrying out warranty tests, delivery of the system into operation.

Mounting of sensor units and cable routing is performed by the Customer.

The proposed system can be introduced during 4 months.