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High efficiency secondary reformer burner

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GIAP group of companies ("GIAP") involves three design institutes – OJSC GIAP, NIAP Ltd., Khimtekhnologiya Ltd. OJSC GIAP was established in 1931 as research and design institute for nitrogen industry. OJSC GIAP is also leading and managing organization for GIAP group of companies. The number of GIAP staff exceeds 450. Offices are located in Russia, Estonia and Ukraine.

GIAP is an expert and technology developer in areas such as ammonia, nitric acid, ammonium nitrate, urea, as well as methanol, acetic acid, and acetylene.

The main activity of GIAP is the design of chemical plants. GIAP licenses technologies, provides basic designs, supports Authority Engineering (according to the norms of the Russian Federation) and detail designs.

In addition, GIAP develops highly efficient equipment for ammonia units. Such equipment includes the burner (air distributor) for the secondary reforming reactor.

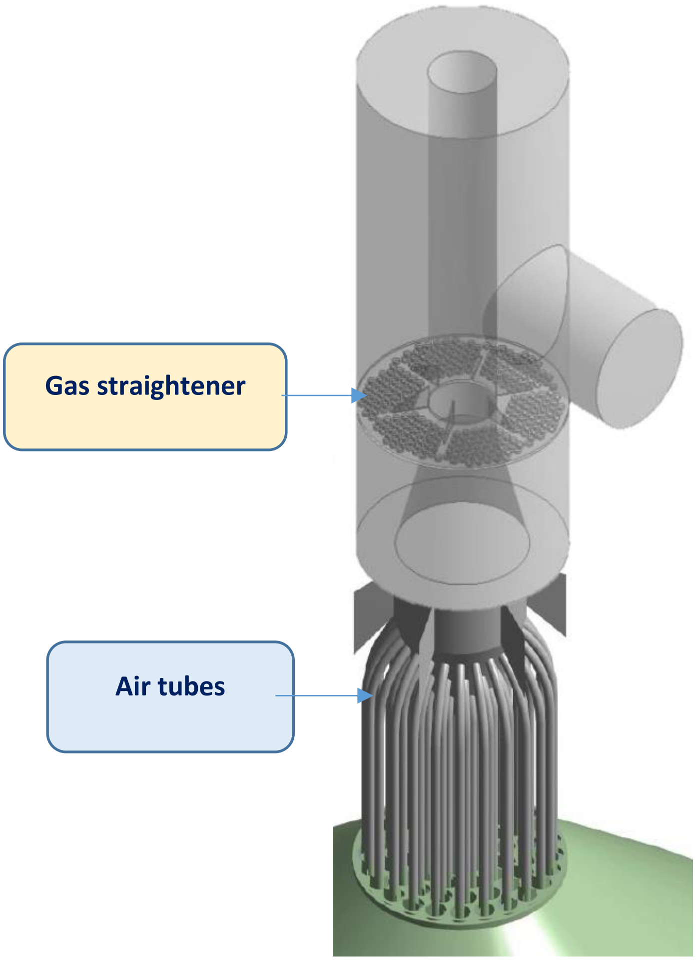

Fig. 1

GIAP has developed the original design of the burner (see Fig. 1).

The gas flow is leveled using a gas streightener installed in the annular space of the reactor below the inlet pipe. After the straightener, the gas passes between the air tubes and then goes through the lower grid to mix with the air-steam mixture.

The straightener and the grid together with the space formed by the housings of the neck and the air-steam distributor are designed to ensure uniformity of the gas flow between the tubes at the outlet of the neck.

Air-steam mixture is fed into the distribution chamber, in the cone-spherical part of which the tubes are welded. To align the speeds of the air-steam mixture over the cross section of the distribution chamber, a perforated grille is installed. Tube ends are equipped with air-steam swirlers.

The burner of this design was supplied to, methanol and acetylene plants. In total, about 40 burners were manufactured and supplied for enterprises in the CIS, Lithuania and China.

However, so far the burner has not been supplied to large-capacity units such as TEC and AM-70/76. Therefore, a burner project was developed for a large-capacity unit operating at an increased capacity of 1,750 tons of ammonia per day. Reactor inlet conditions are shown below.

Component	Estimated value (dry), %	Estimeted value (wet), %
H_20	-	43.78
H_2	70	39.35
CH_4	9.5	5.34
CO_2	10	5.62
CO	9.3	5.23
Ar	1.2	0.34
N_2	1.2	0.34

Reformed gas parameters:
Dry gas flow – 152800 Nm^3/hr
Wet gas flow – 271800 Nm3/hr
Inlet temperature – 810 C^o
Inlet pressure – 33 kgf/cm^2

Air-steam parameters:
Dry air flow – 63580 Nm3/hr
Steam flow – 10000 Nm3/hr
Inlet temperature- - 440 C^o
Inlet pressure – 34.5 33 kgf/cm2

On the basis of these conditions, three-dimensional hydrodynamic modeling (CFD) was carried out to identify the temperature fields and gas velocities in the combustion zone.

Fig. 2 shows the gas velocity field and the flow lines of gases in the combustion zone, which indicate the effective leveling of the flow rates before the gas enters the catalyst bed.

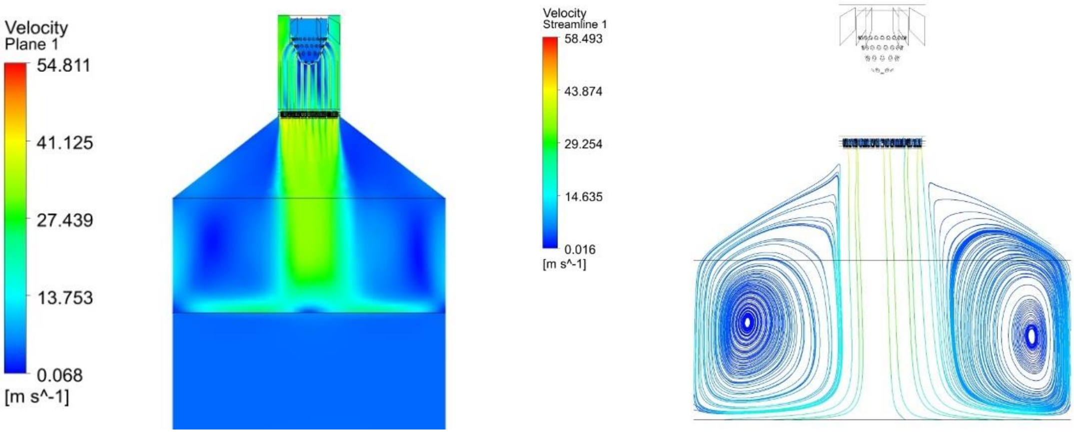

Рис. 2 Поле скоростей и линии тока газа в зоне горения.

Fig. 3 shows the temperature distribution in the combustion zone. The gas temperature above catalyst is 1250 ° C, and the standard deviation does not exceed 2.6%.

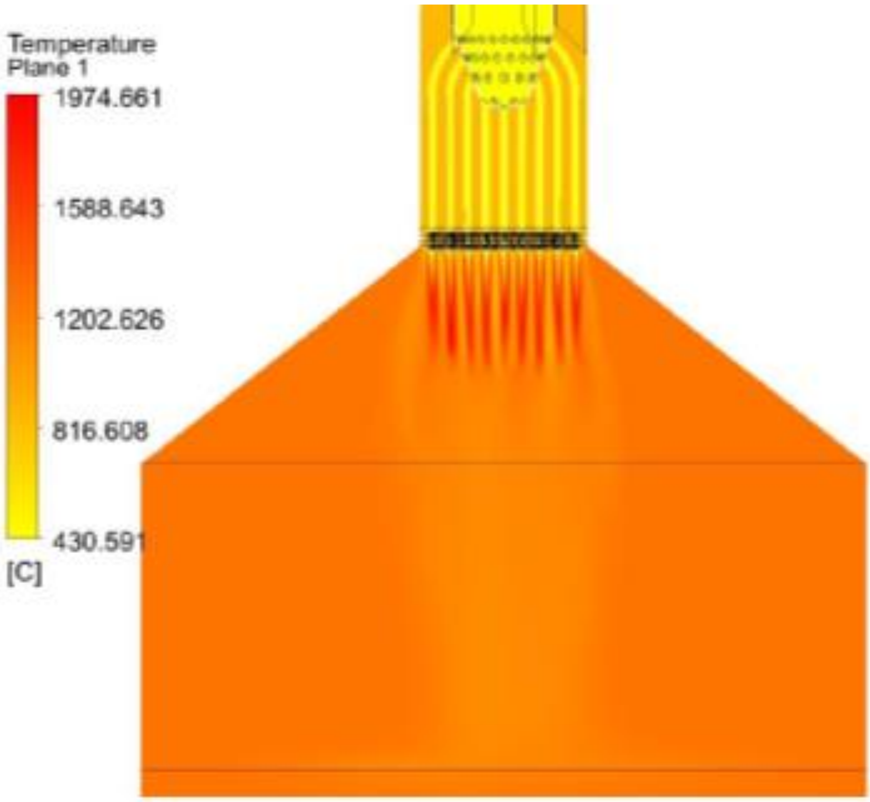

Рис. 3 Поле температур.

According to the CFD modelig, it can be concluded that the design of the burner is effecient, since the velocity field of the gas above the catalyst is generally uniform (except for a small zone in the center), and the calculated average temperature is close to the expected (the difference less than 10 ° C, which is 0.79%).