НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ
ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

Technology and project of installation of flue gas drying with utilizing the heat of water vapor condensation

associate professor, Vladimir I. Bespalov
engineer, Victor V. Bespalov

Tomsk CHP-3

director: Oleg V. Kovalev
chap engineer: Roman E. Bober

Features of gas-fired

$$CH_4 + 2O_2 = CO_2 + 2H_20$$

The combustion products of natural gas contain water vapor (about 150 g per 1 kg of dry gas) which are carried away through the chimney.

If this water vapor is condensed via some device, then it will be possible to obtain the amount of heat sufficient to heat the 7 kg of air on 50 °C

(for example, from -20 to +30°C).

The technical offer

Integrated energy-saving solution

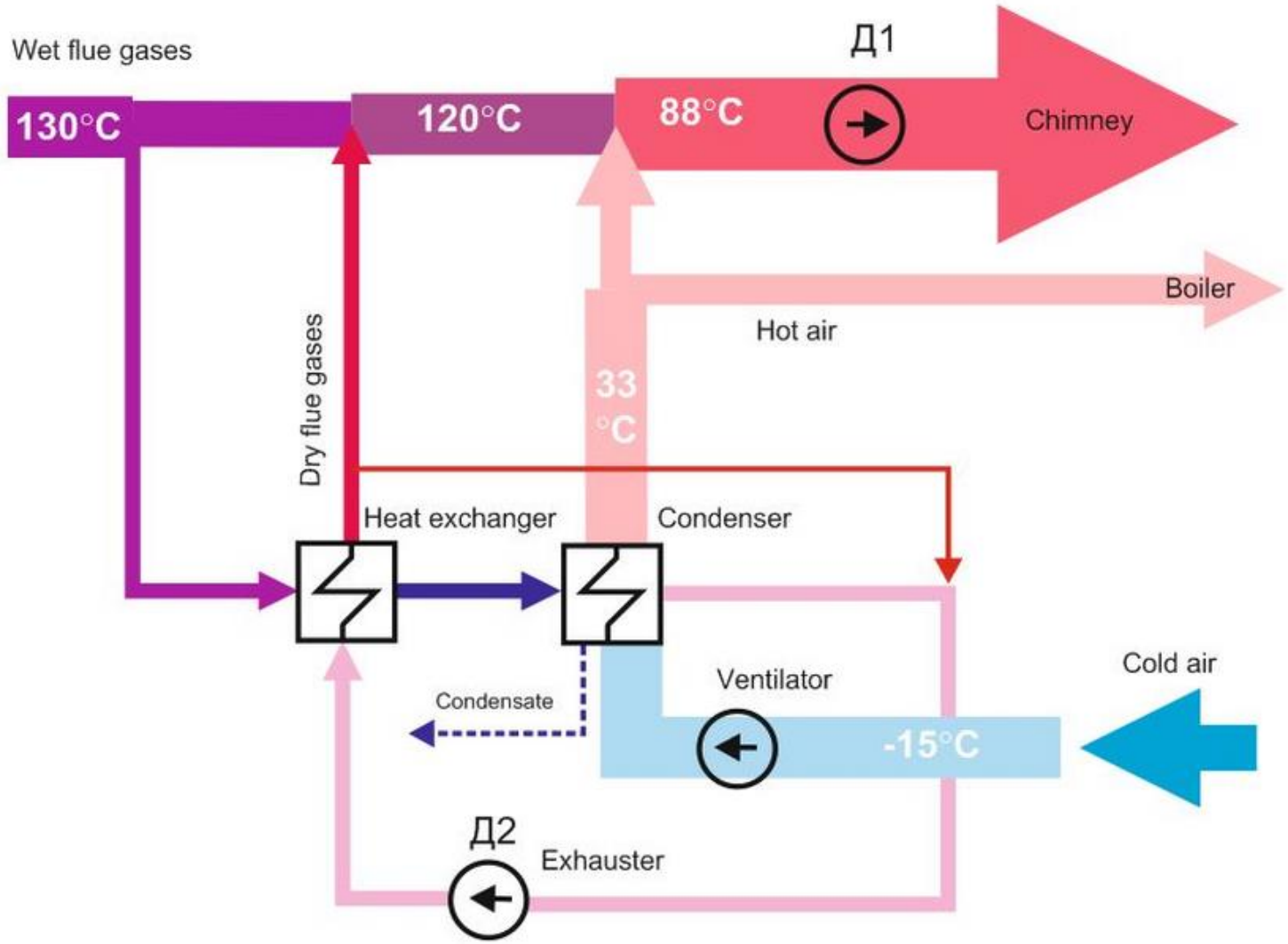
Drying of the flue gases.

- **Reduction of the dew point.**
- **Prevent the condensation in the chimney.**

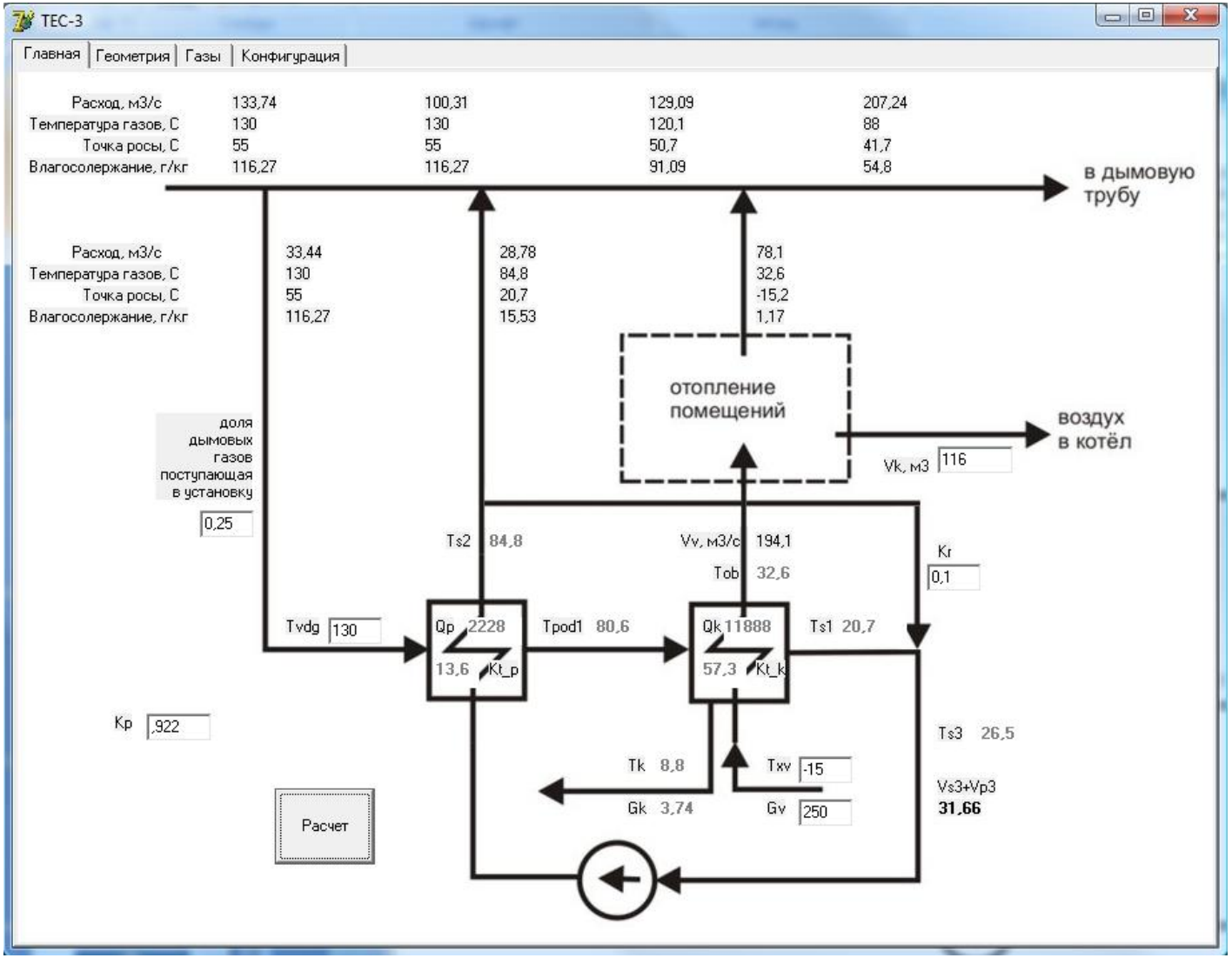
Heat utilization of flue gas.

- **Using the heat of water vapor condensation contained in flue gases for heating industrial premises and heating the air for the boiler.**

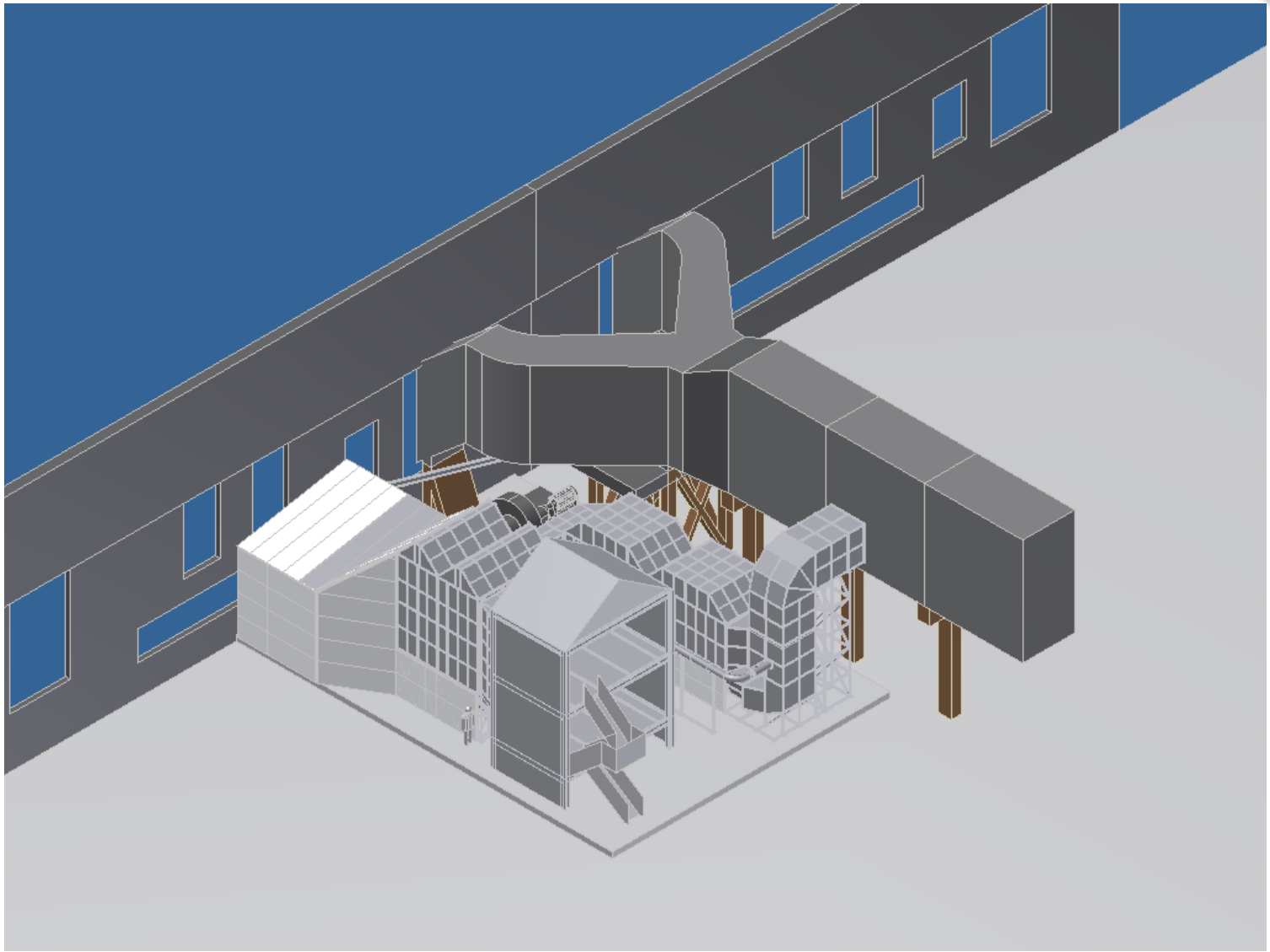
Improving boiler efficiency.


Wet flue gases
130°C
120°C
88°C
Д1
Chimney
Boiler
Hot air
33 °C
Dry flue gases
Heat exchanger
Condenser
Condensate
Ventilator
Cold air
-15°C
Д2
Exhauster

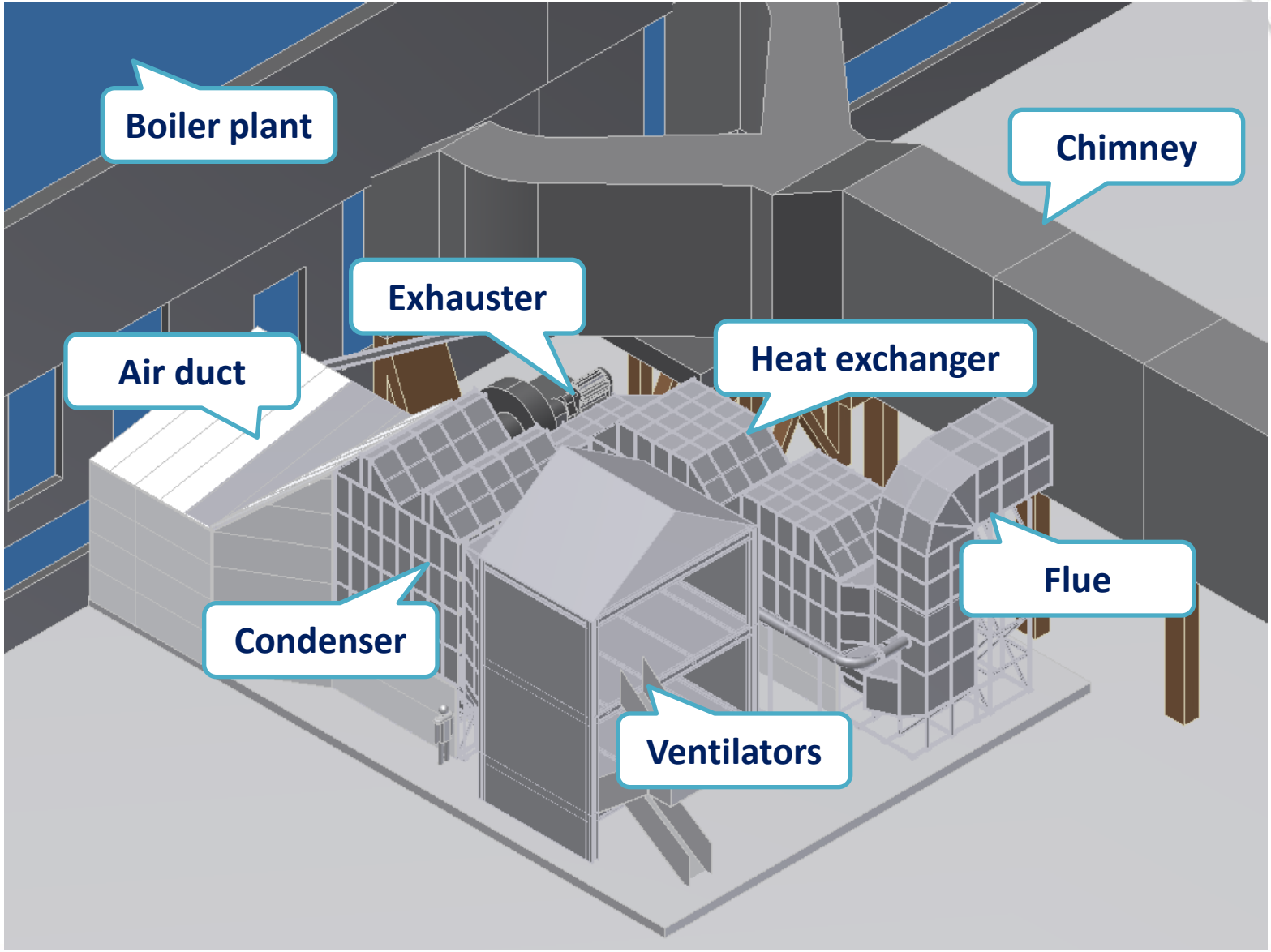
The mathematical model of the installation

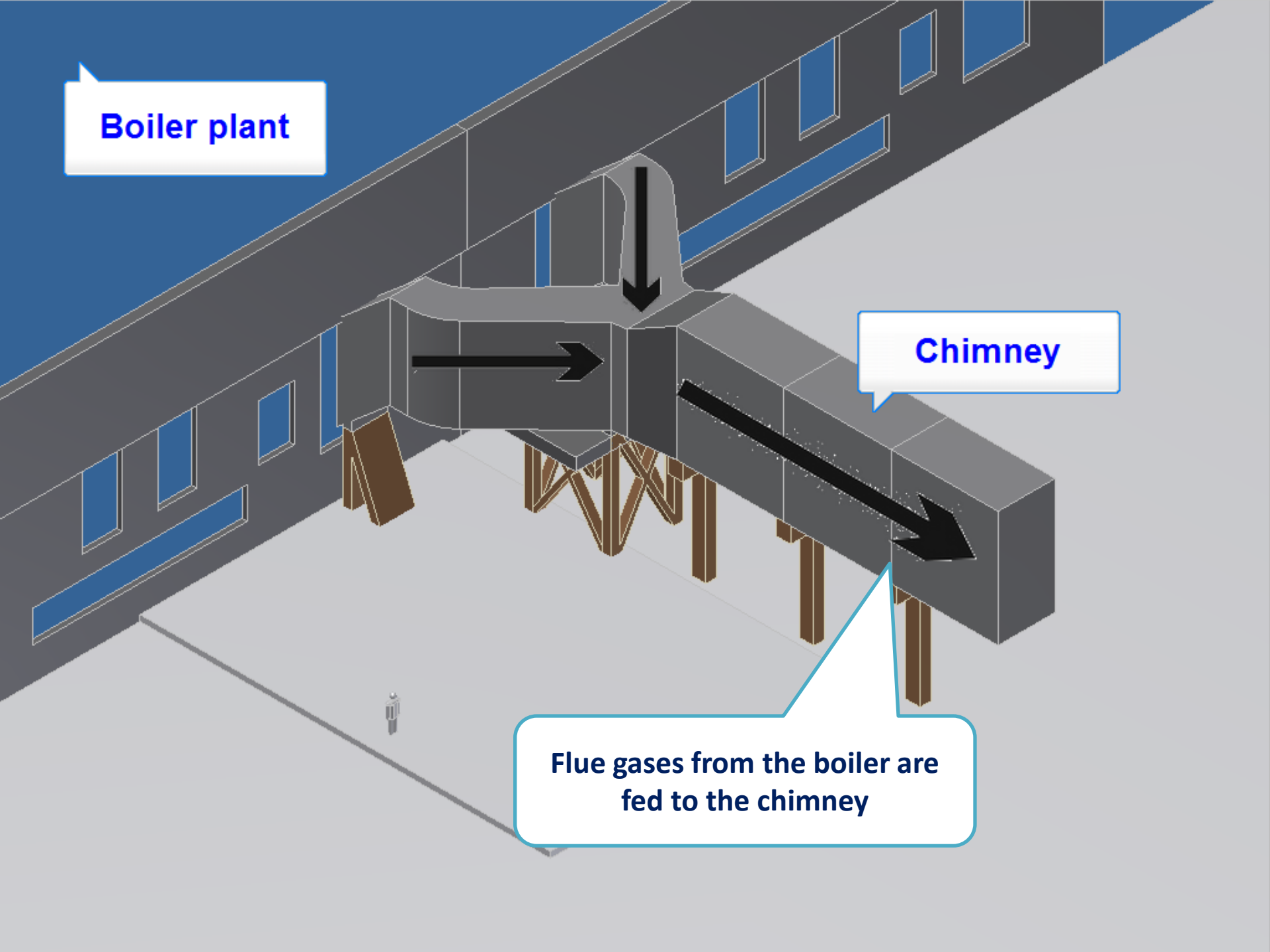


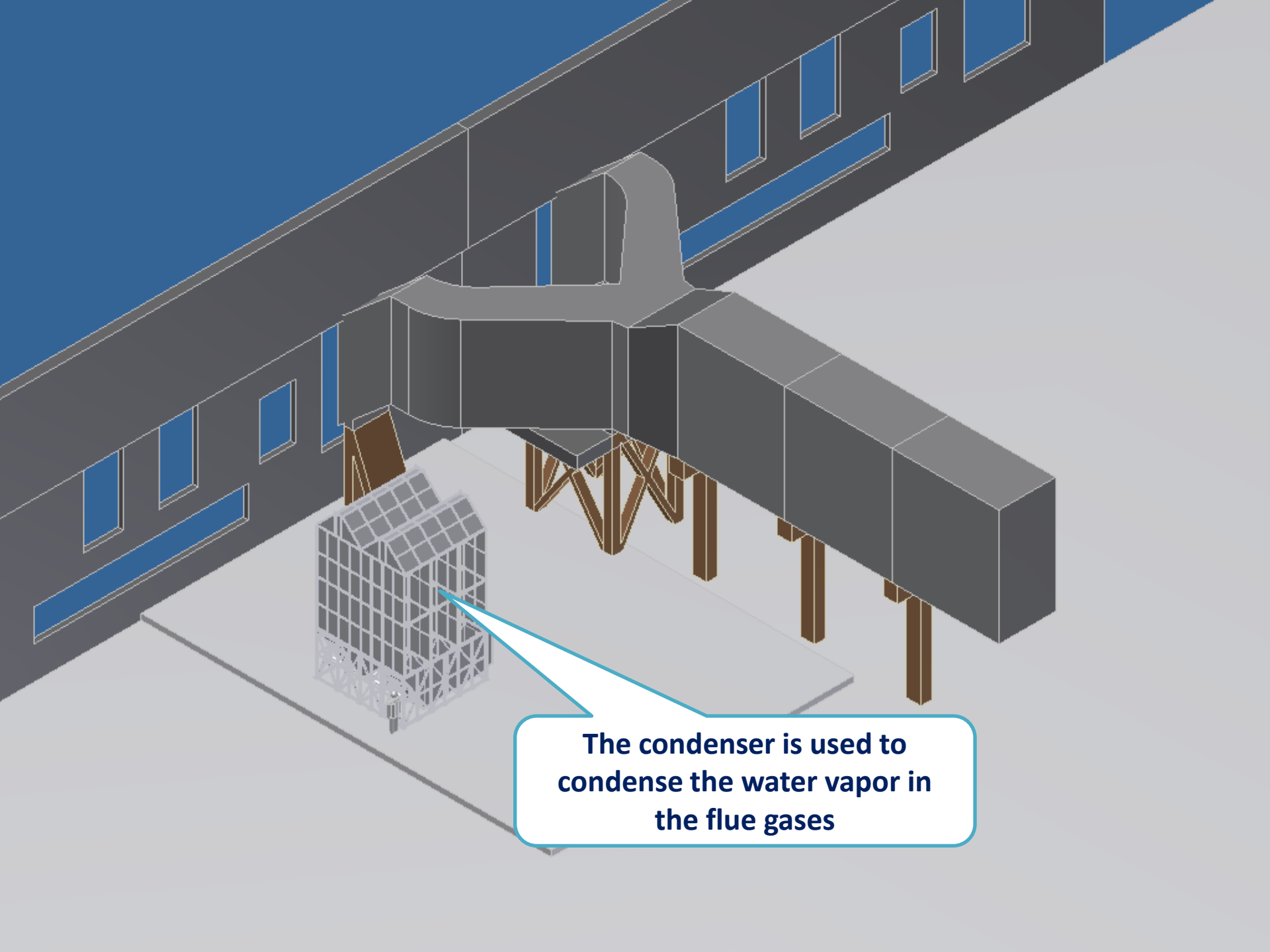
The technology of flue gas heat utilization is implemented in the Installation of drying flue gas of gas-fired boiler

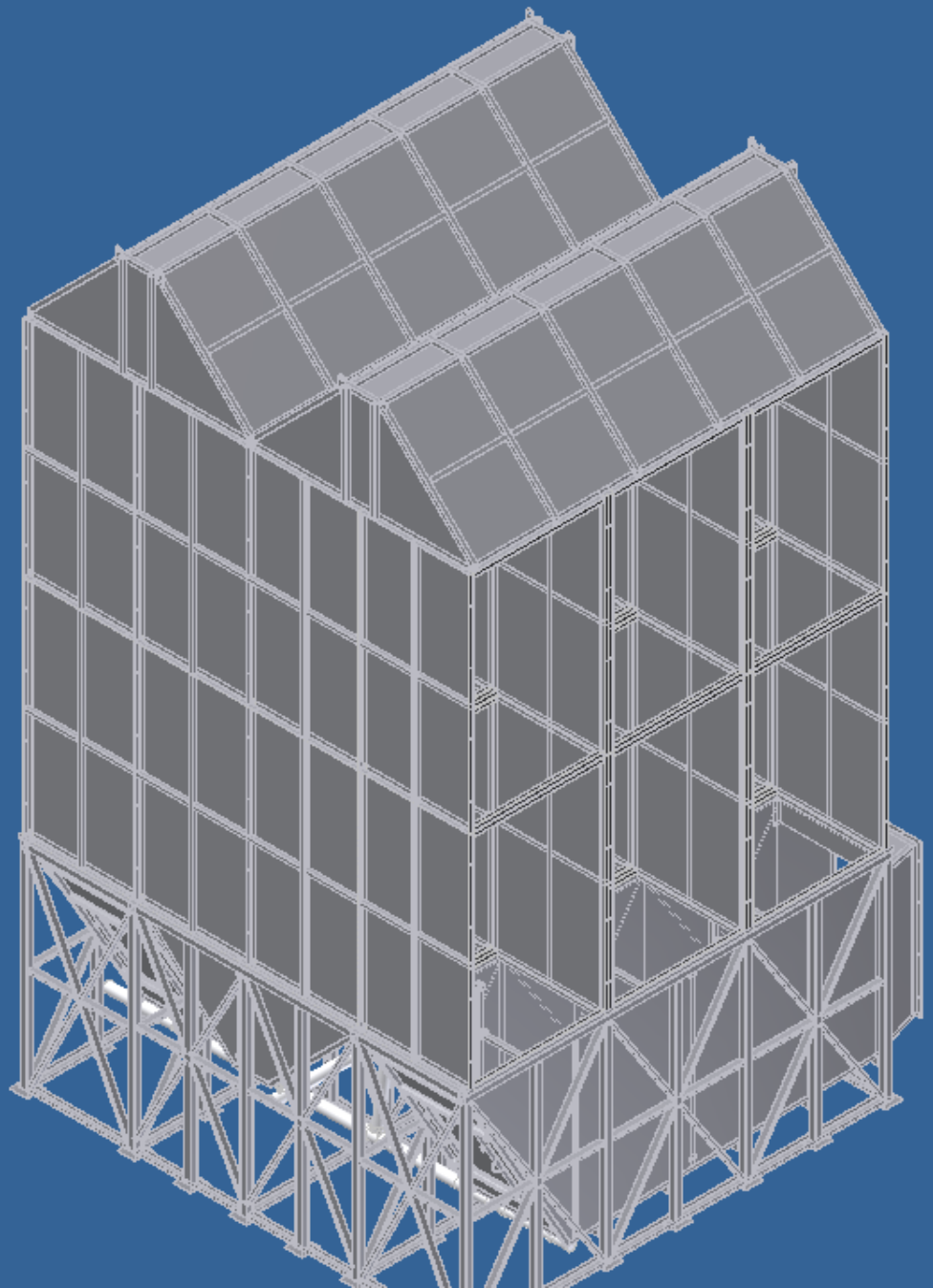


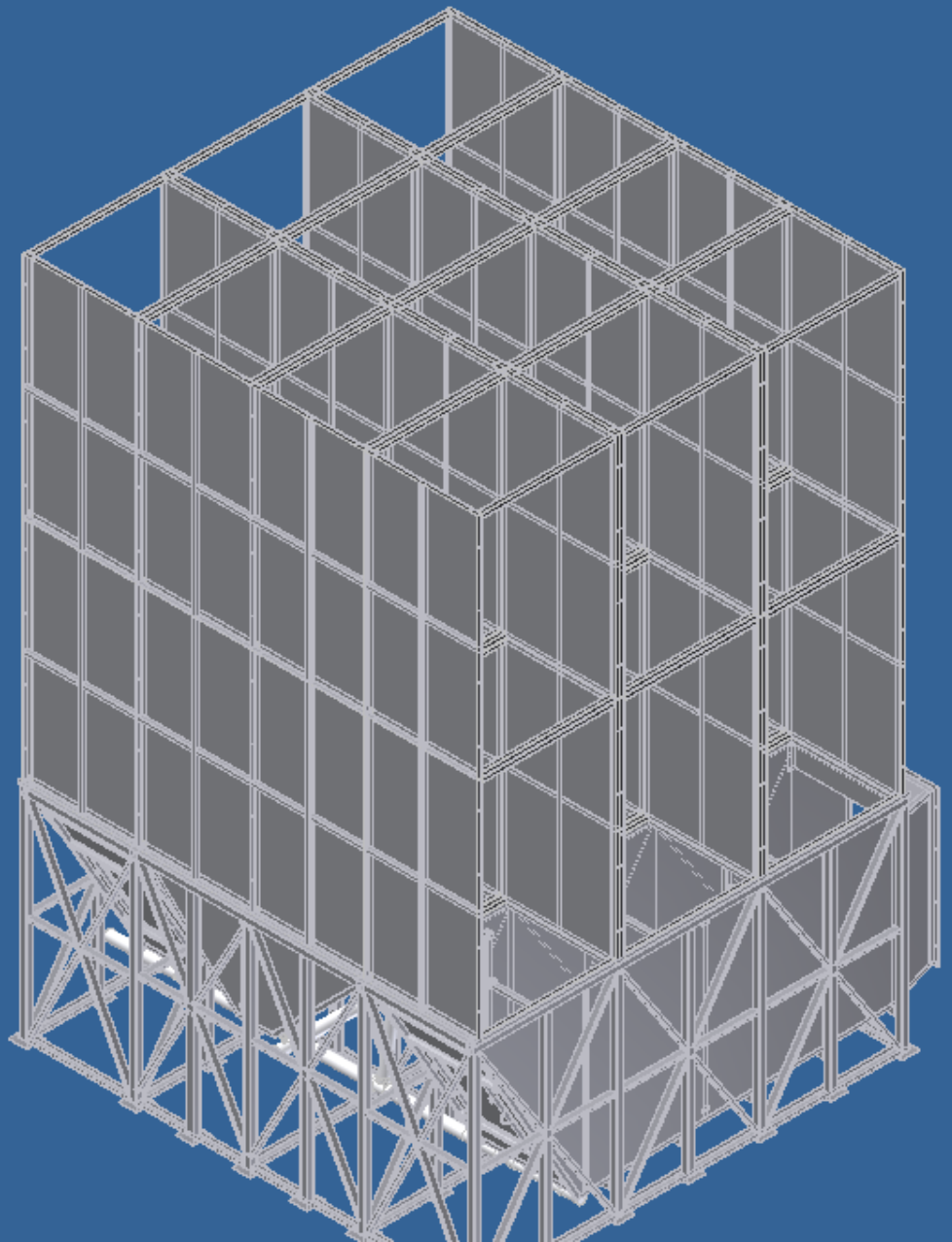
The installation set up outside the boiler plant, near the chimney, and consist of

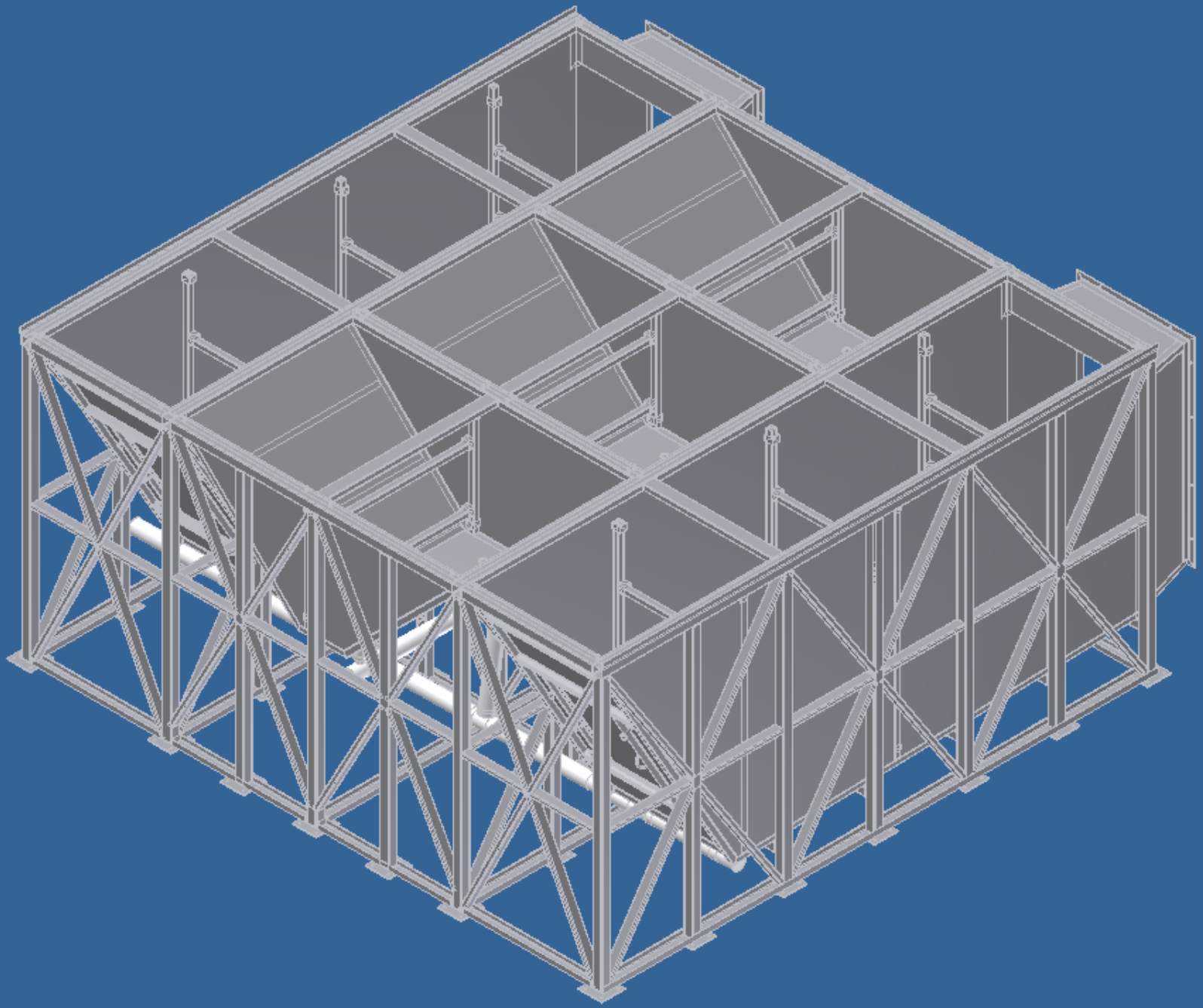


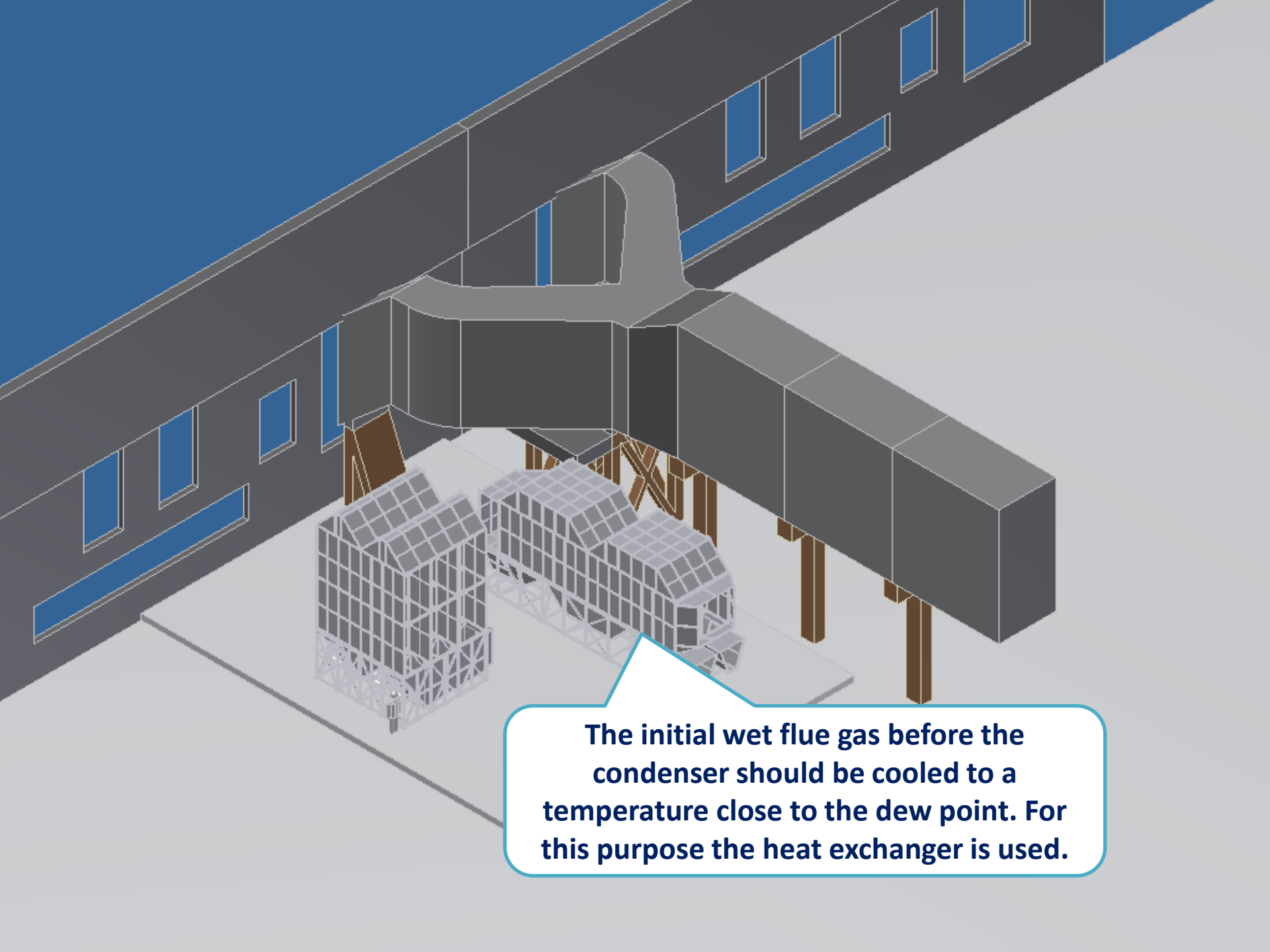

Boiler plant
Chimney
Flue gases from the boiler are fed to the chimney

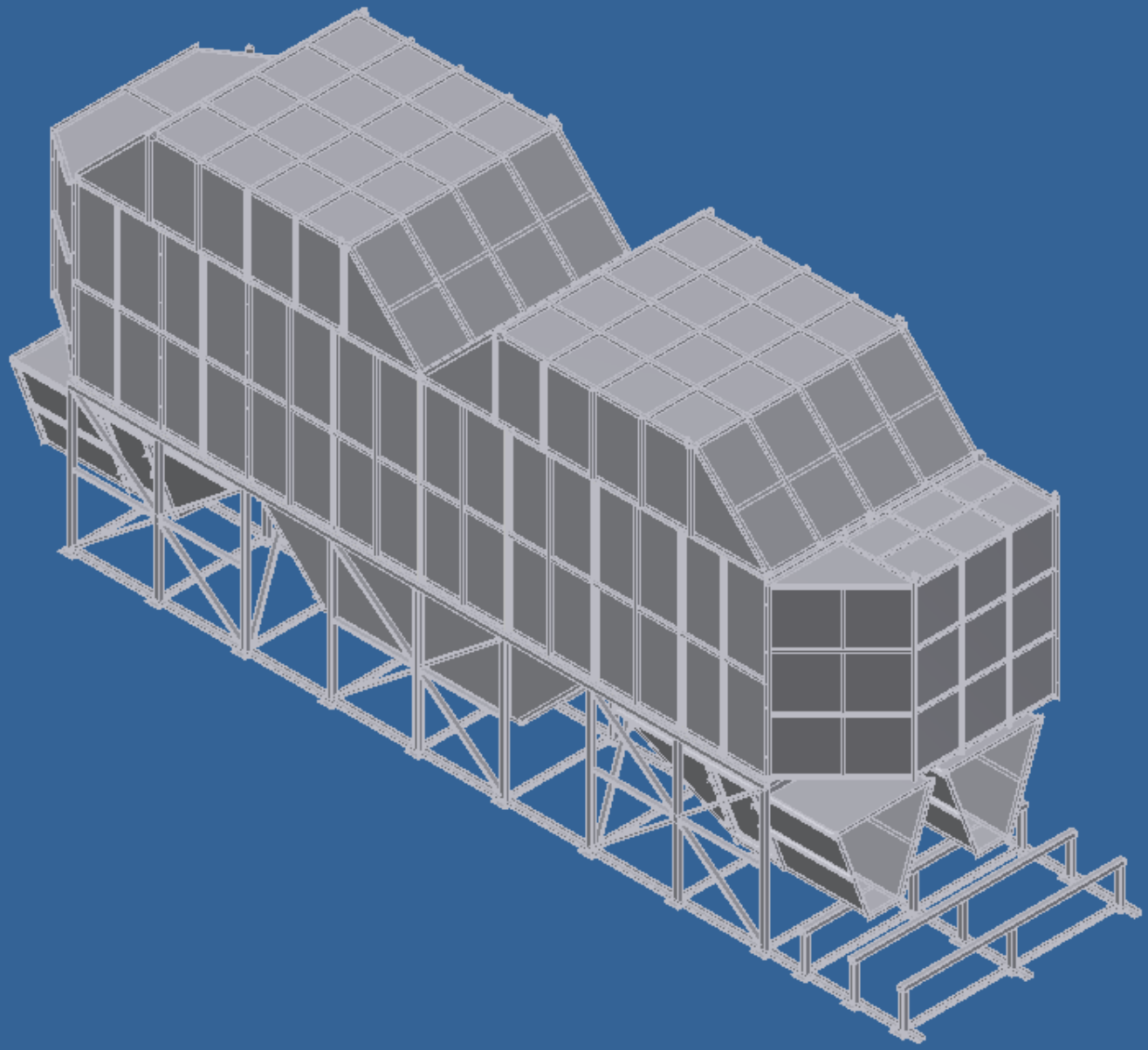

The condenser is used to condense the water vapor in the flue gases

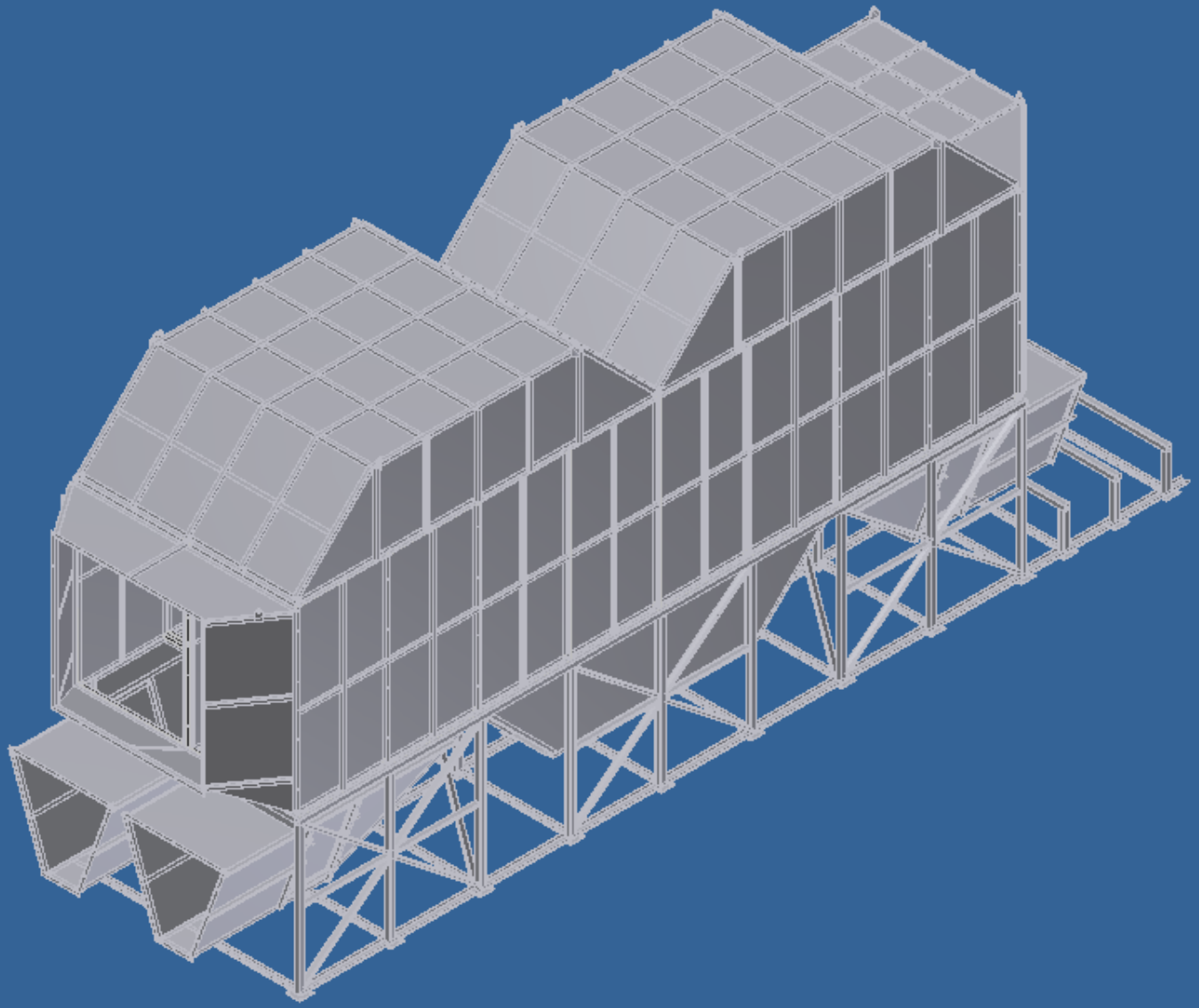


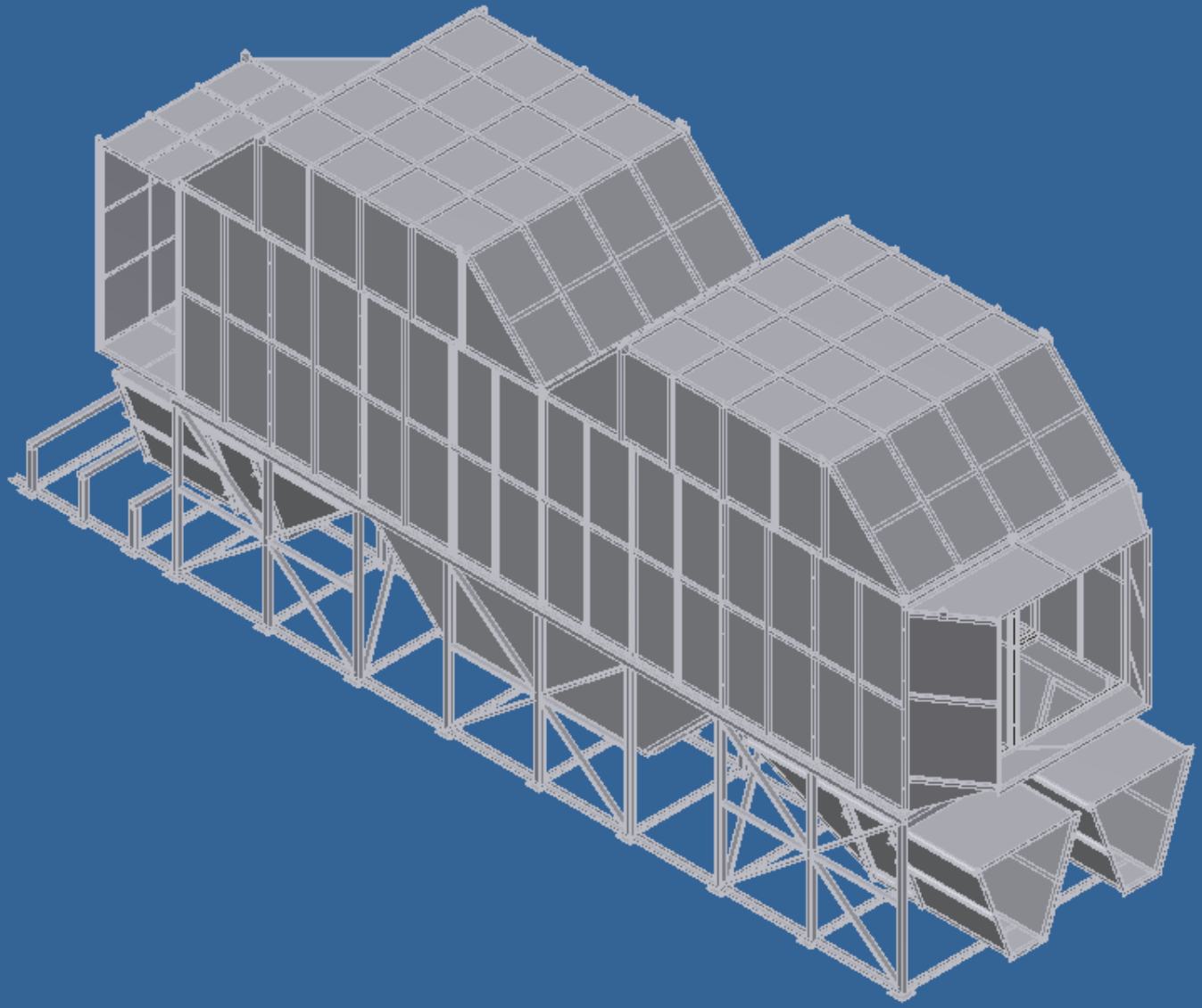


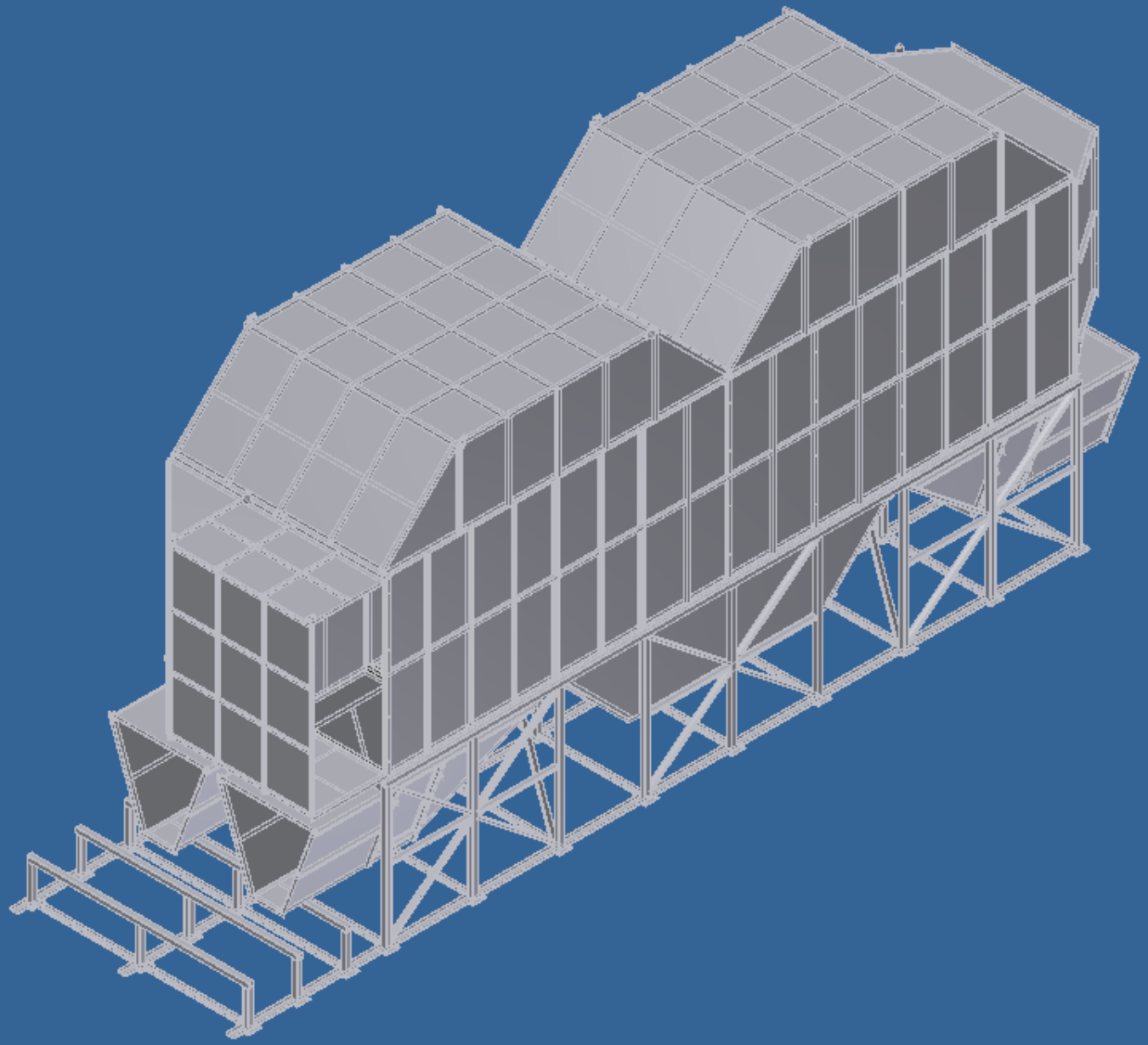


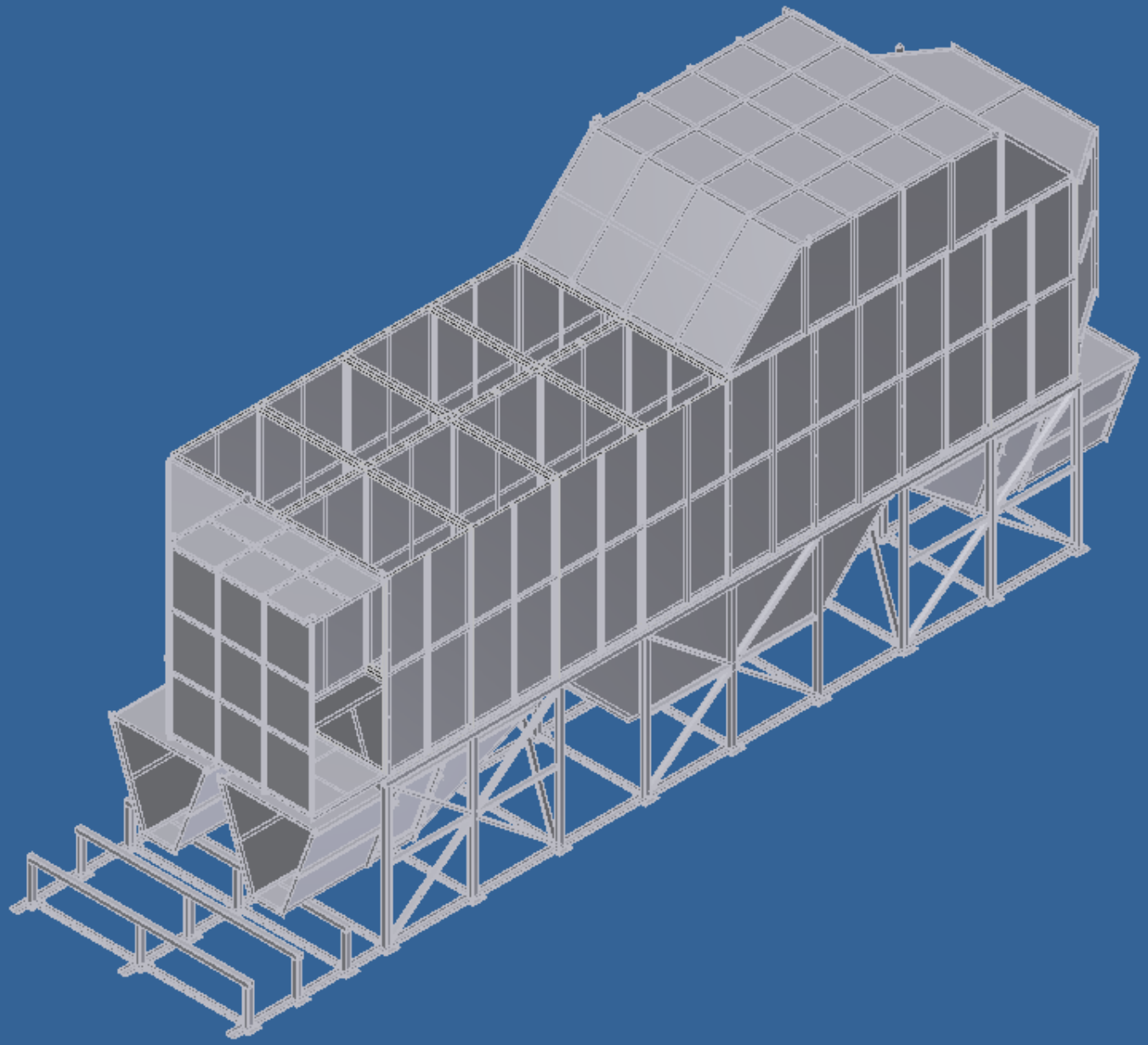

The initial wet flue gas before the condenser should be cooled to a temperature close to the dew point. For this purpose the heat exchanger is used.

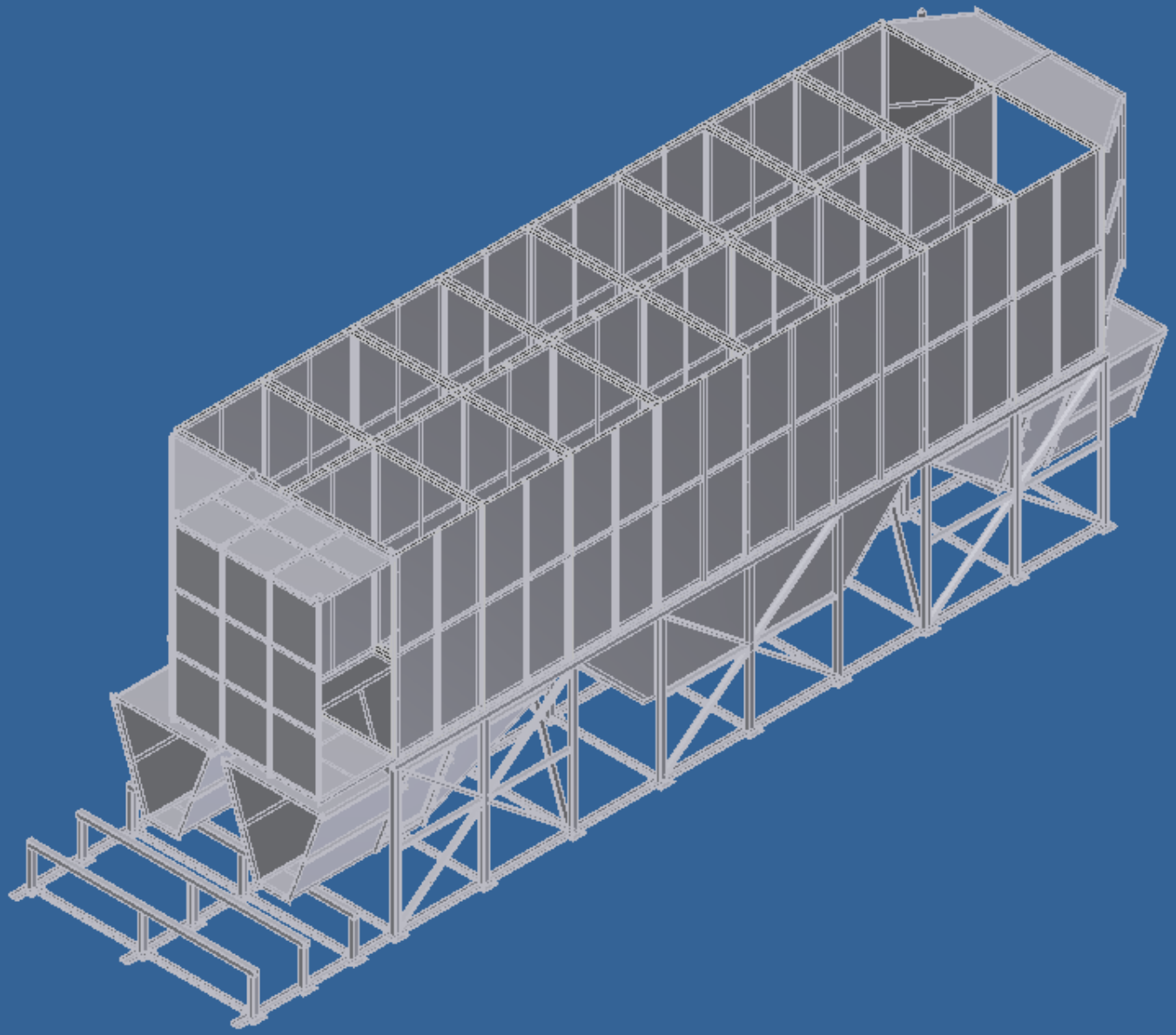


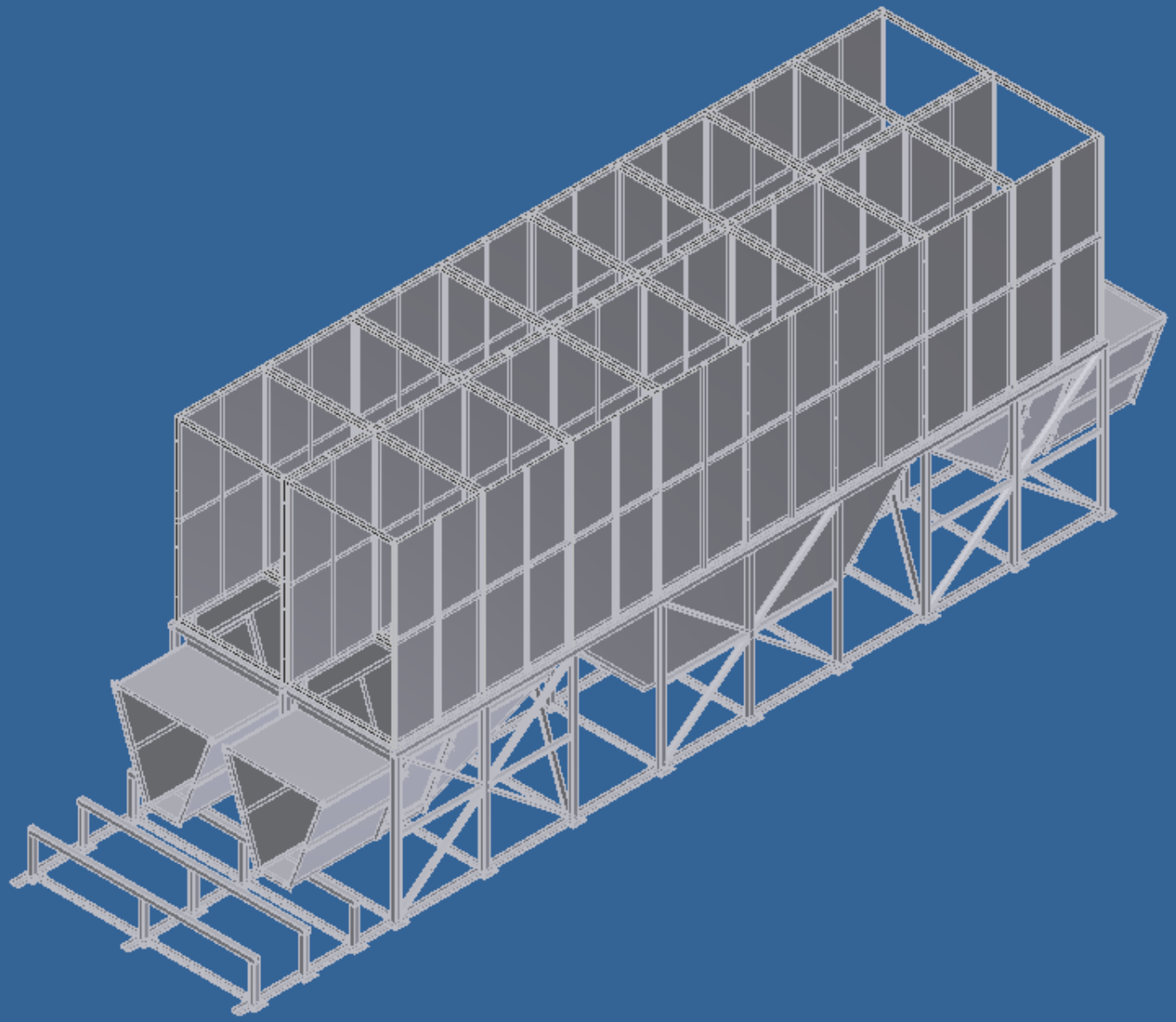


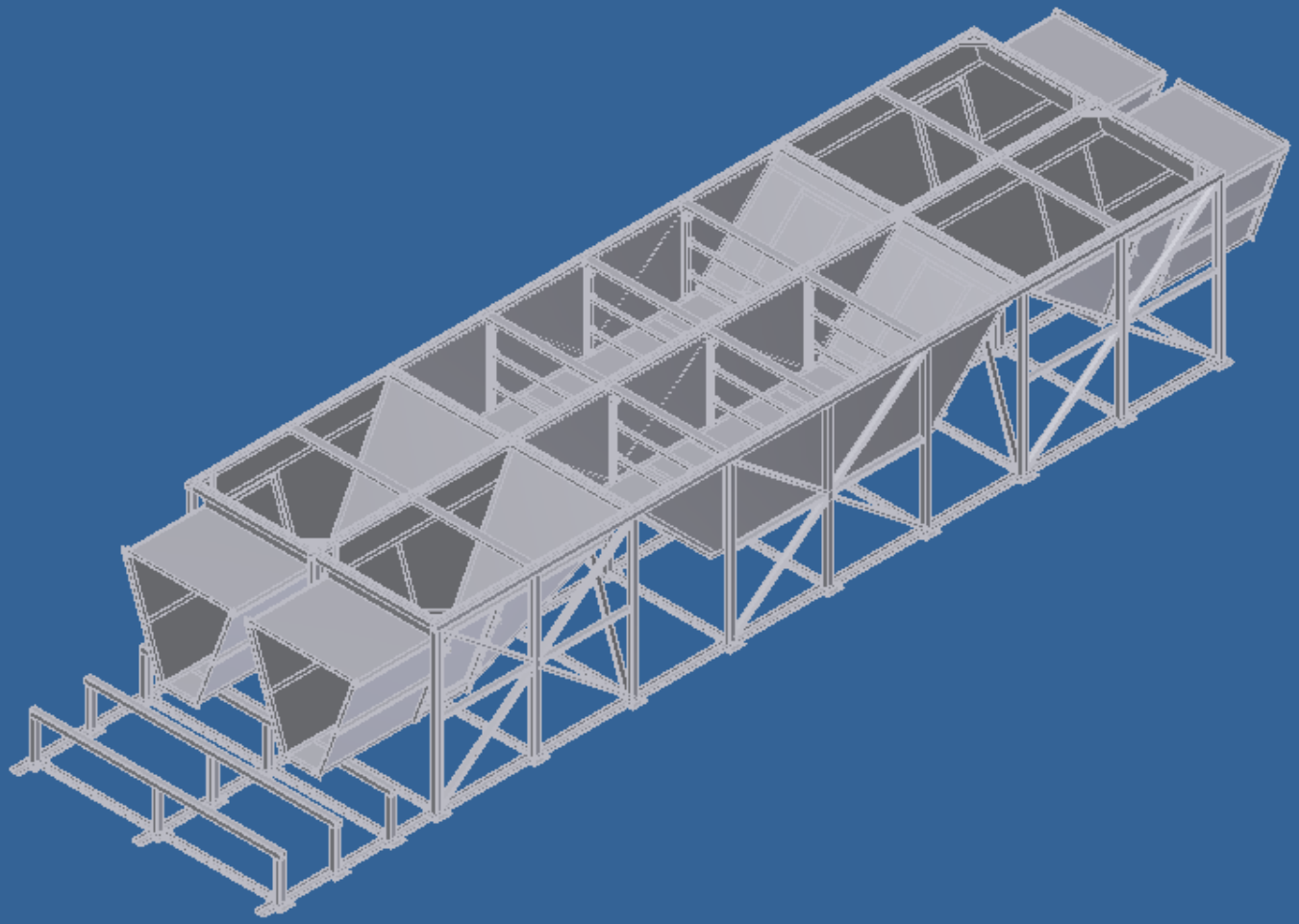


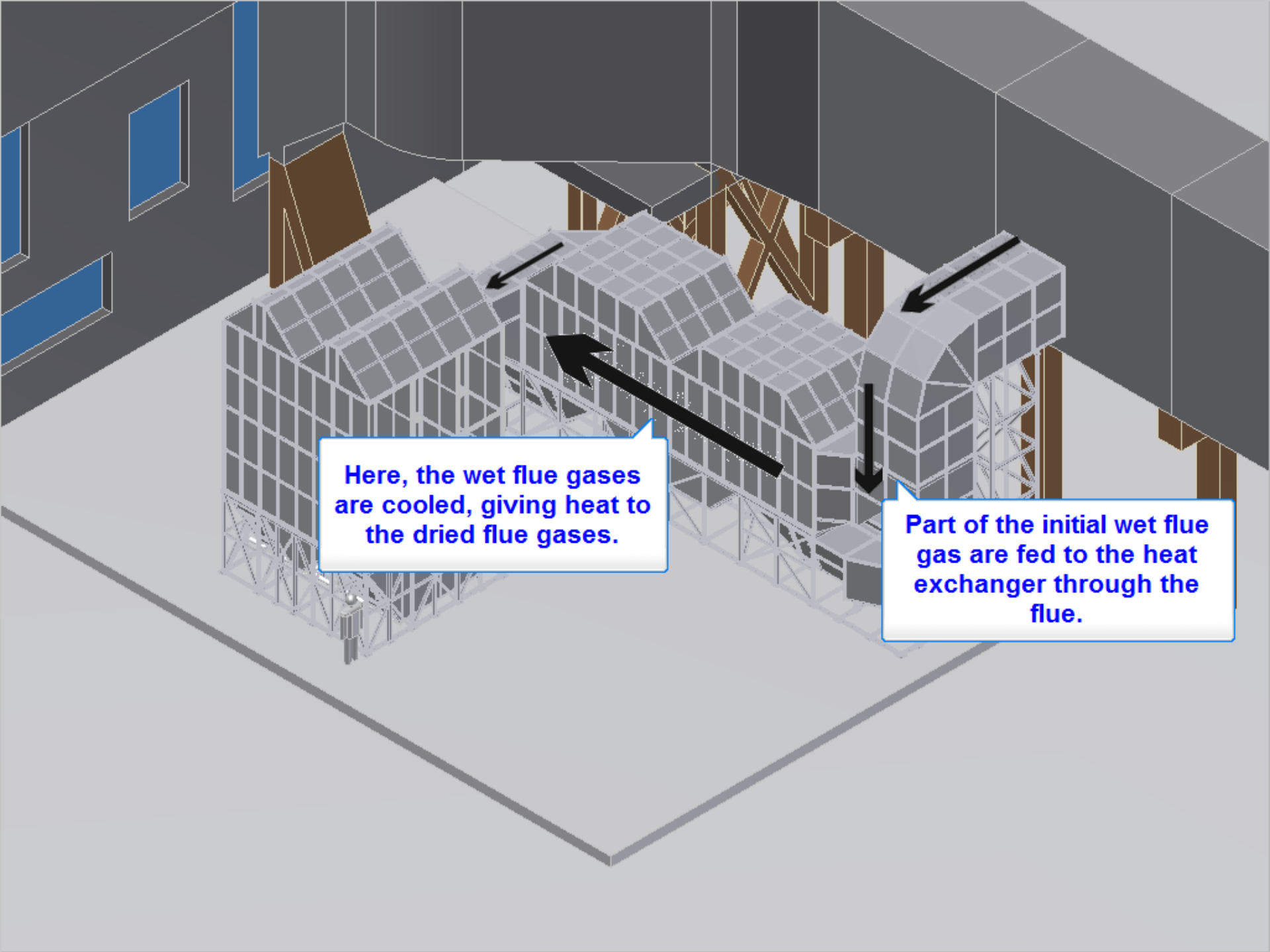






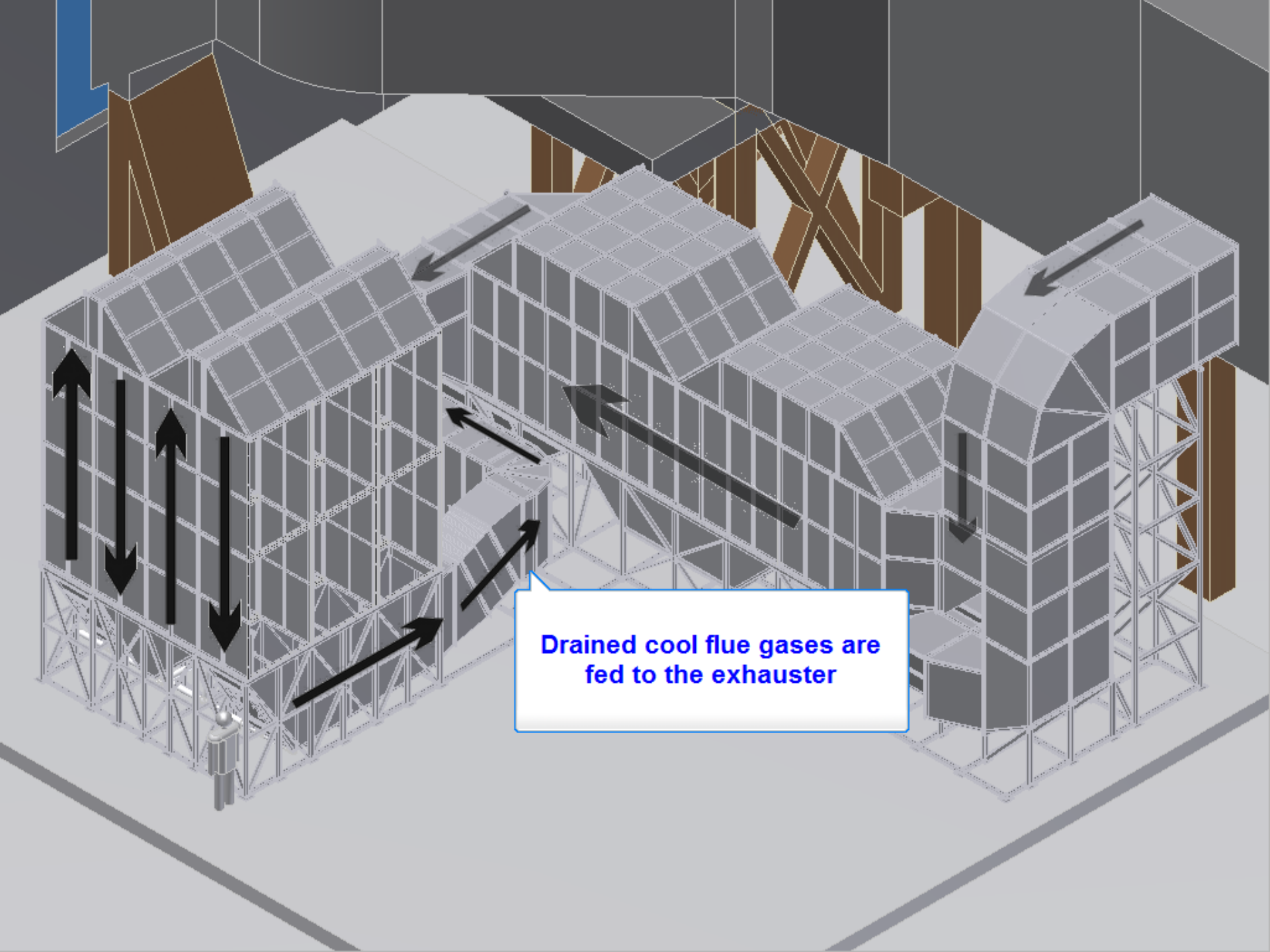





Here, the wet flue gases are cooled, giving heat to the dried flue gases.
Part of the initial wet flue gas are fed to the heat exchanger through the flue.

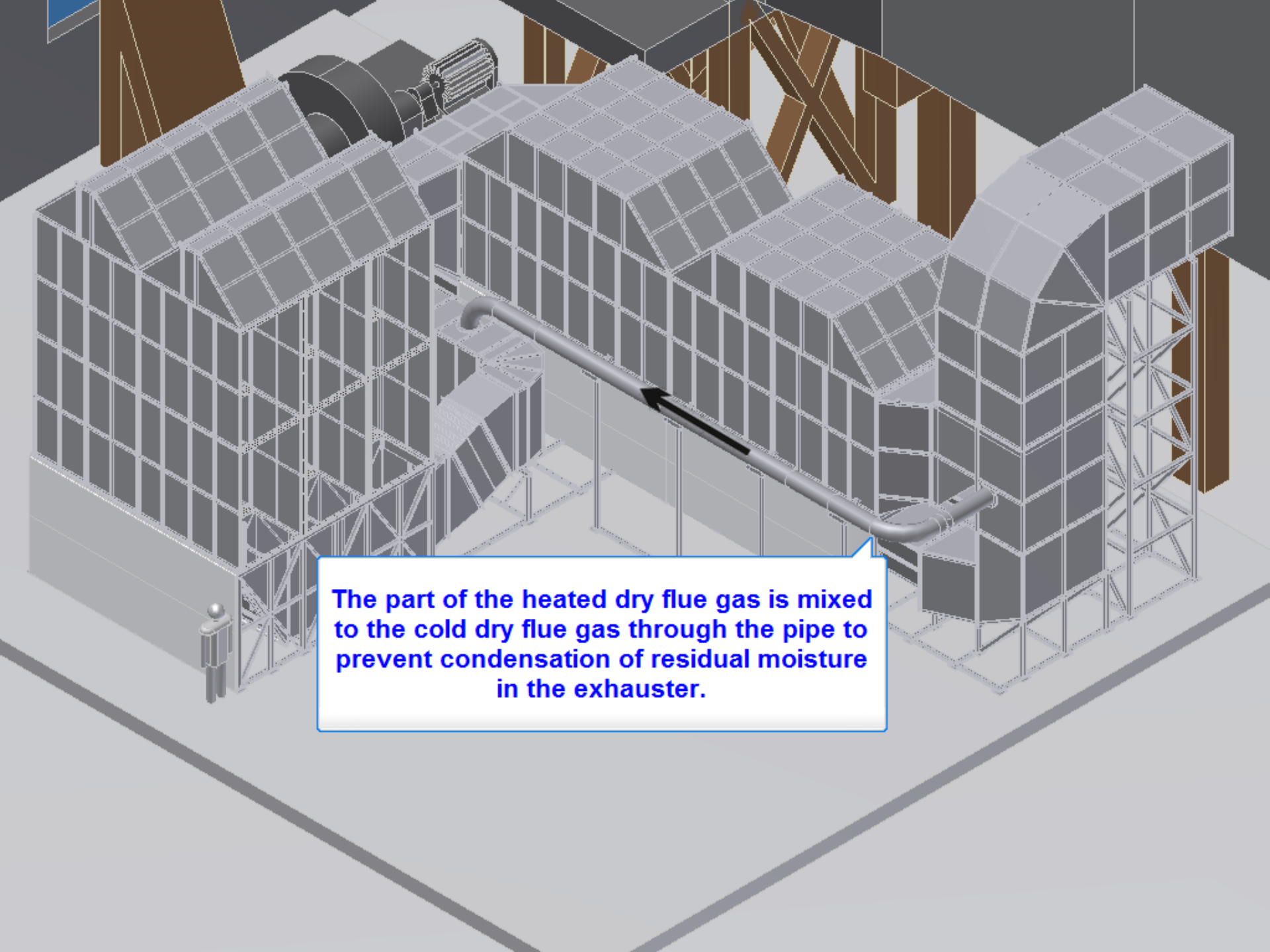

The cooled wet flue gases pass to the condenser.

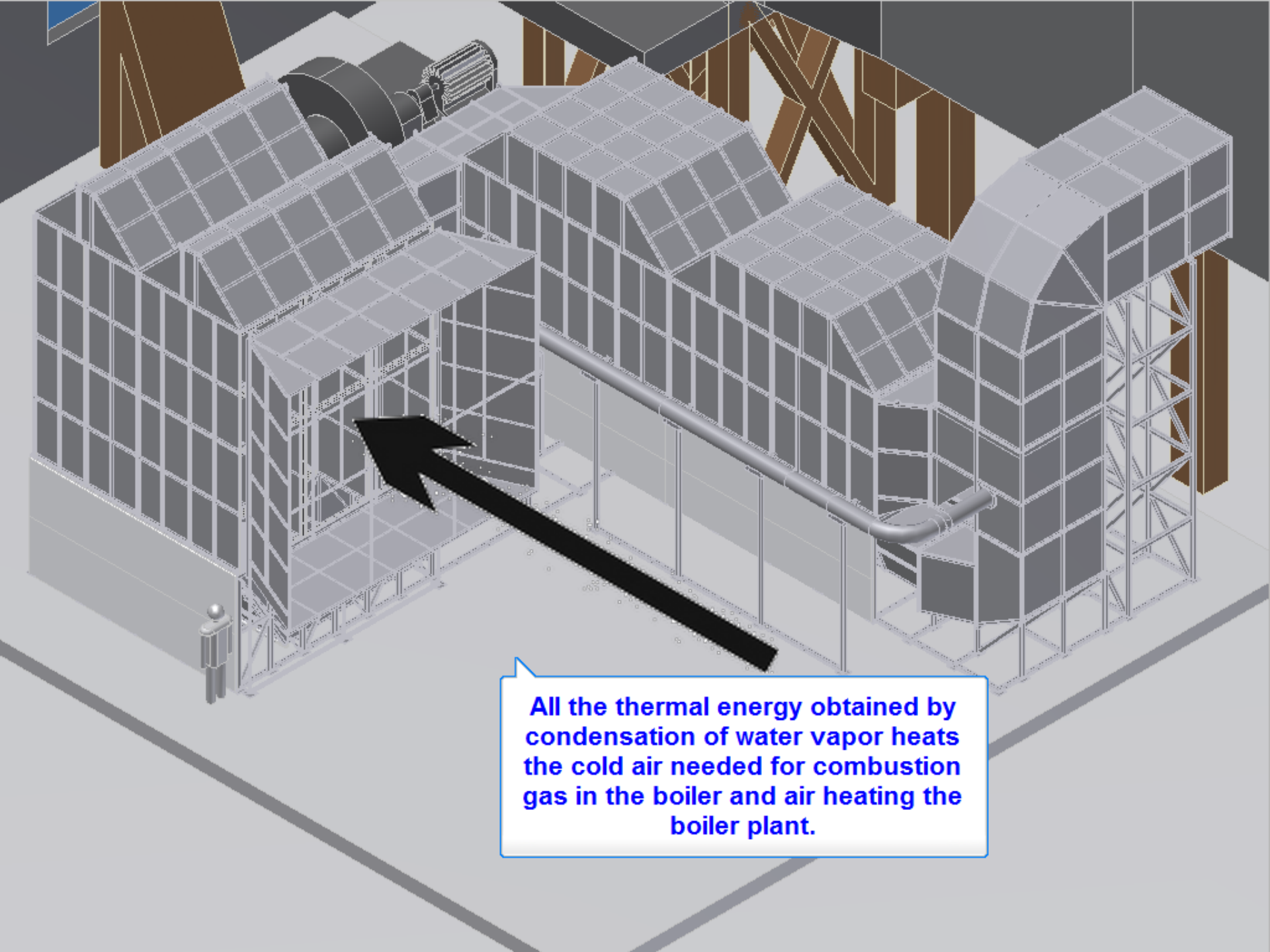

The water vapor condenses when the wet flue gases pass through the condenser's tunnels.


Drained cool flue gases are fed to the exhauster

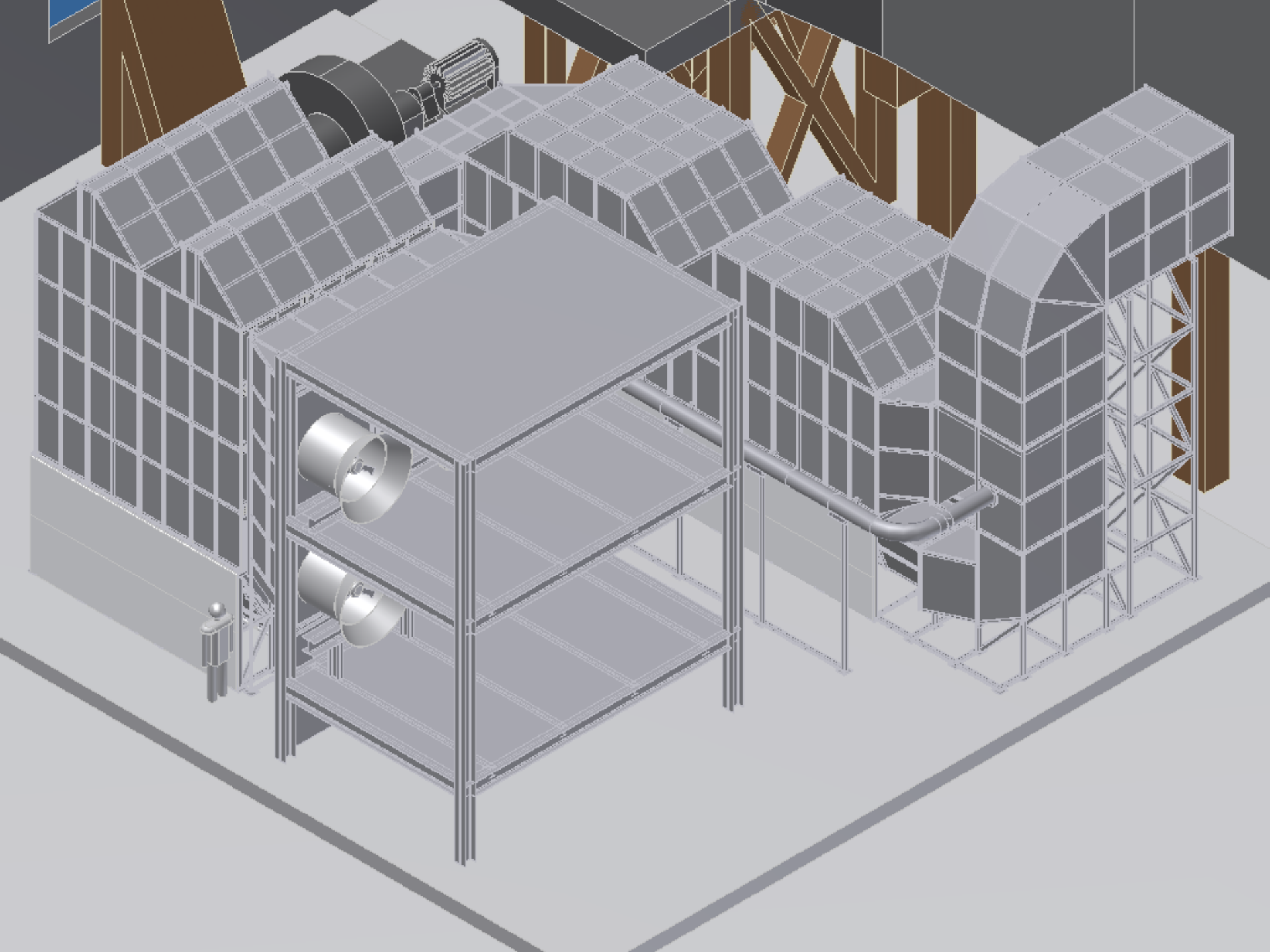

The exhauster compensates the loss of pressure in the tracts of flues, the heat exchanger and condenser.

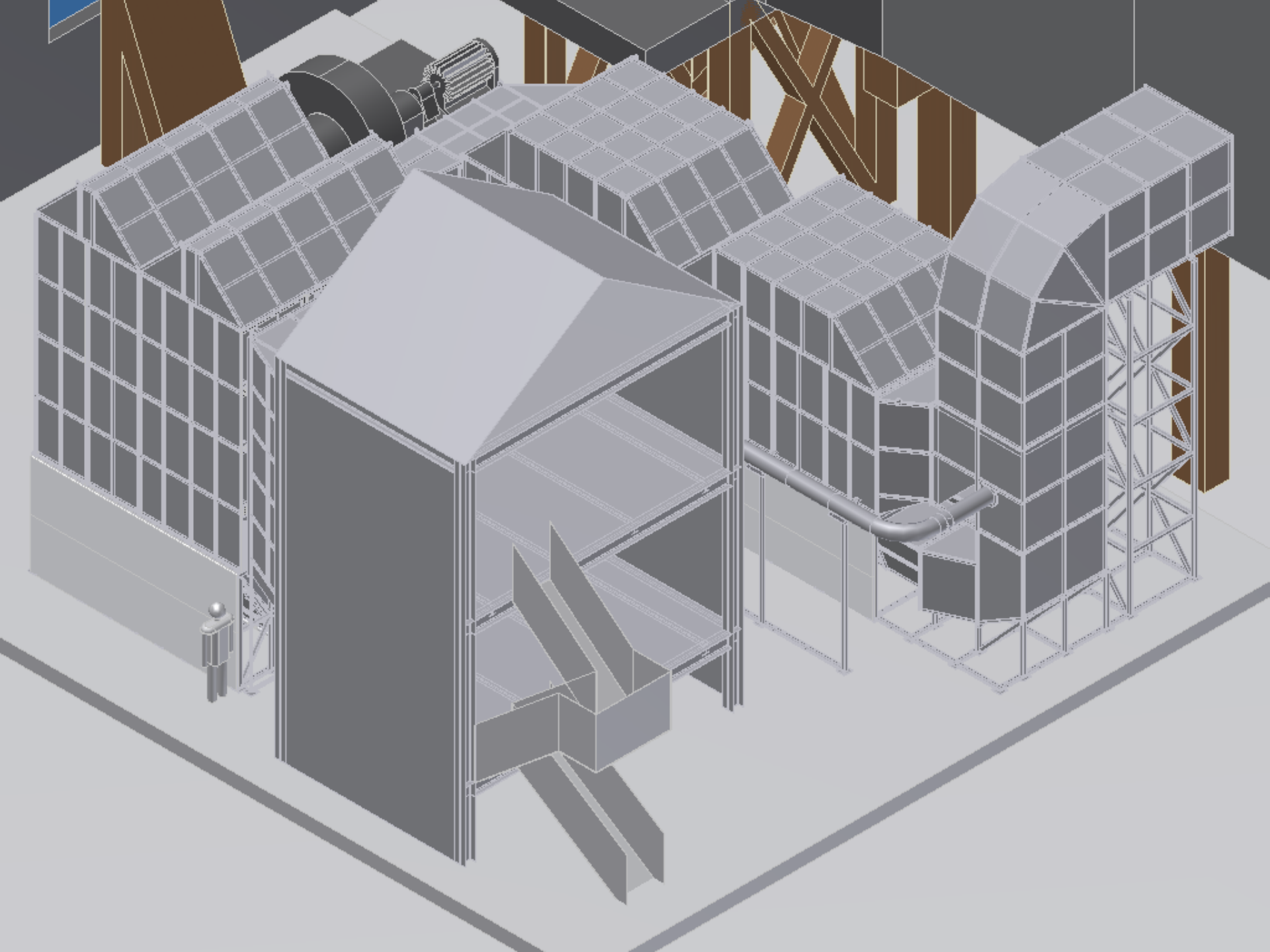

Cold dried flue gases are heated by the heat of initial wet flue gases in a heat exchanger and fed to the chimney.

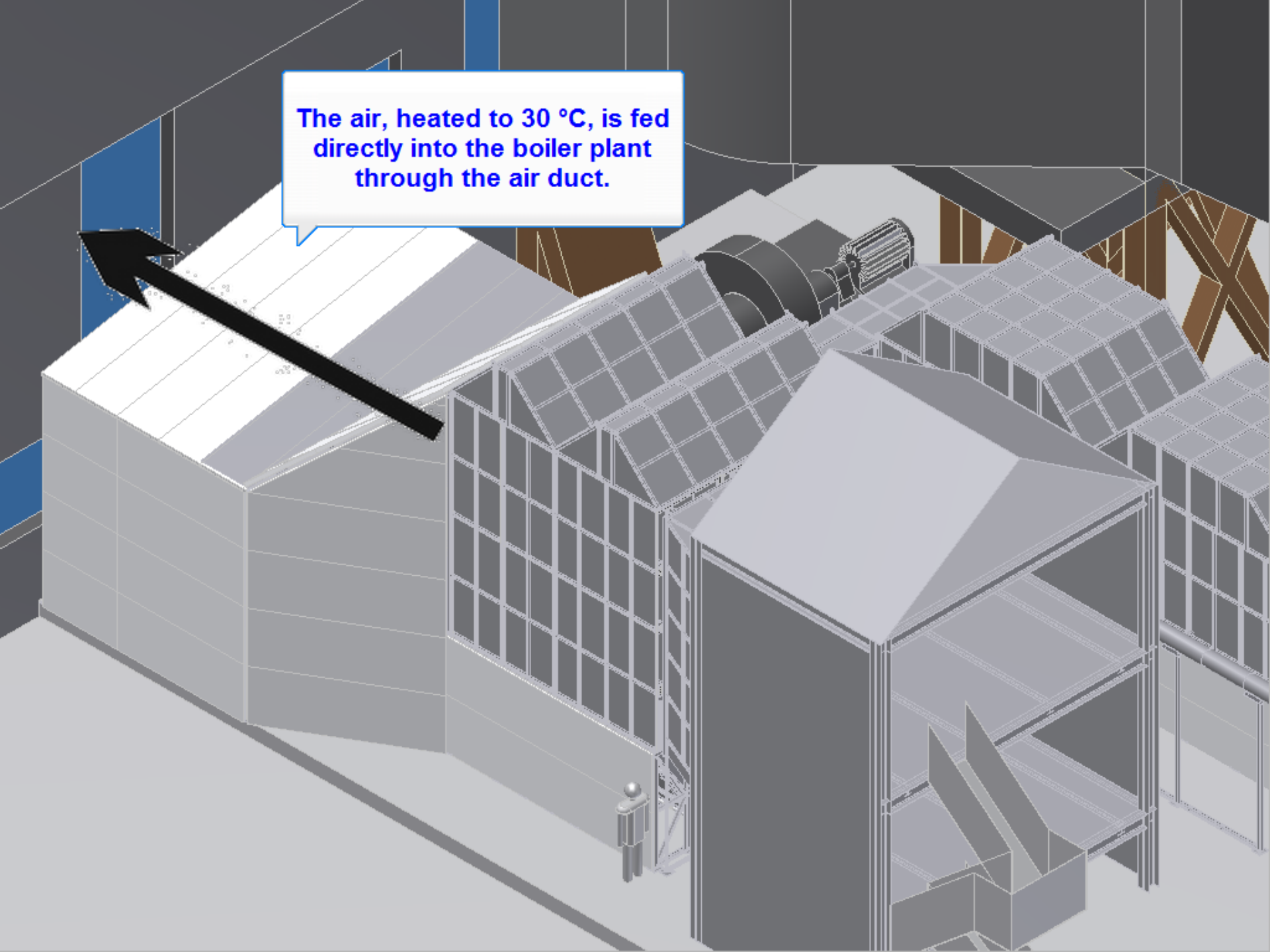

The part of the heated dry flue gas is mixed to the cold dry flue gas through the pipe to prevent condensation of residual moisture in the exhauster.


All the thermal energy obtained by condensation of water vapor heats the cold air needed for combustion gas in the boiler and air heating the boiler plant.


Cold air is fed to the condenser by ventilators.






The air, heated to 30 °C, is fed directly into the boiler plant through the air duct.

Constructional features

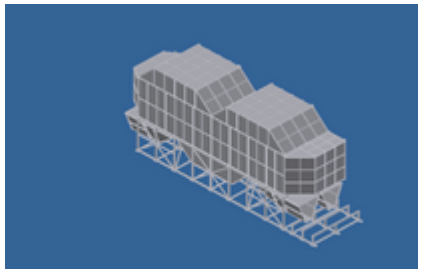
The heat exchanger and the condenser are assembled from the unificated packages, which are the plate heat exchanger units with an area of heat transfer 206.6 m^2 and weight 1203 kg.

The heat exchanger

Area of heat transfer: 3306 m^2

Weight: 27 tons.

Number of the unificated packages: 16

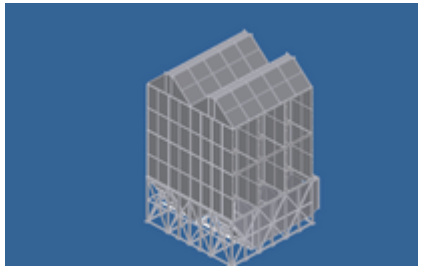


The condenser

Area of heat transfer: 4959 m^2

Weight: 36 tons.

Number of the unificated packages: 24



Energy characteristics

The used volume of flue gas Vdg = 33,44 m^3/s

Reduction of flue gas temperature

after the adding of heated air to 85 °C

Reducing of vapor's dew point temperature to 42 °C

Thermal capacity **Q = 11,9 MW**

Heating the air from -15 to **32,6 ° C**

- The volume of heated air **Vv = 194 m^3/s**
- including to the boiler supply Vk = 116 m^3/s

Amount of condensate Gк = 13,5 t/h

Improving boiler efficiency by **2,3%**

Assessment of economic efficiency

There are results of economic calculations of using the instalation for Tomsk CHP-3. The number of hours with a negative temperature outside air - 5000 h/year.

The capital investments - 27 million rubles.

The thermal capacity of the unit - 11 MW

for ambient temperatures from 0 to - 20 °C .

Additional heat production per year - 55,000 MW · h

Annual cost reduction will be 27.5 million rubles.

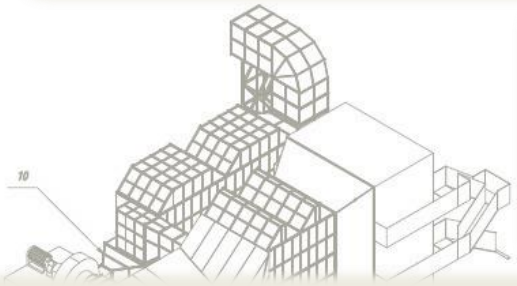
for natural gas costs 2.62 rub./m^3

The payback period of installation is less than one year.

Contact Information

Technological solutions elaboration provide employees of the department of nuclear and thermal power plants, Power Engineering Institute, National Research Tomsk Polytechnic University, which has a patent № 2436011.

The projects performs Design Institute, part of the TPU. There are licenses for all kinds of design work.



Areas of application installations:

1. Power plants, which use natural gas.
2. The local gas-fired boiler plants.

Address: Russia, 634050, Tomsk, Lenina Avenue, 30, building 4, office 112,
tel/fax +7 3822 564170 Vladimir I. Bespalov e-mail: vibsp@tpu.ru
Victor V. Bespalov e-mail: vic@tpu.ru

Will be glad to successful cooperation!

Thank you for attention!