Rakett 21

TAL TECH

Indoor climate

EXPLANATION OF THE TASK

The calculation of buildings' technical systems and energy efficiency is mainly based on thermodynamics. Processes related to solids, liquids and gases are needed in the construction industry. They are already taught in elementary and high school physics, and the knowledge gained in class has great practical value and can be used in real engineering work.

HOW TO COMPLETE THE TASK?

The construction e-competition task consists of different parts; we do not expect you to complete them all. Answers should be given with three digits.
You can submit your answers in Word, Excel or PDF format. You can also write by hand on paper and take a photo of the answers, the main thing is that the solution process and the answers are clearly and comprehensibly visible.

EVALUATION AND SCORING

Points are earned for solving tasks as follows:
1. All parts of the submitted task are checked, the best/most accurate solution gets 100%, the next 91%, 82% ... of the maximum points of the task part.
2. The points of the parts of the team's tasks are added up.
3. 1 penalty point is deducted from the points for each minute of delay in submission.
4. If two teams now have equal points, the team that submitted the answers earlier will have the advantage.
5. The team with more points in this way gets 100 points in the final calculation, the next 91 points, 82 points, etc.
A maximum of 100 points can be obtained in total.

Rakett 21

TAL TECH

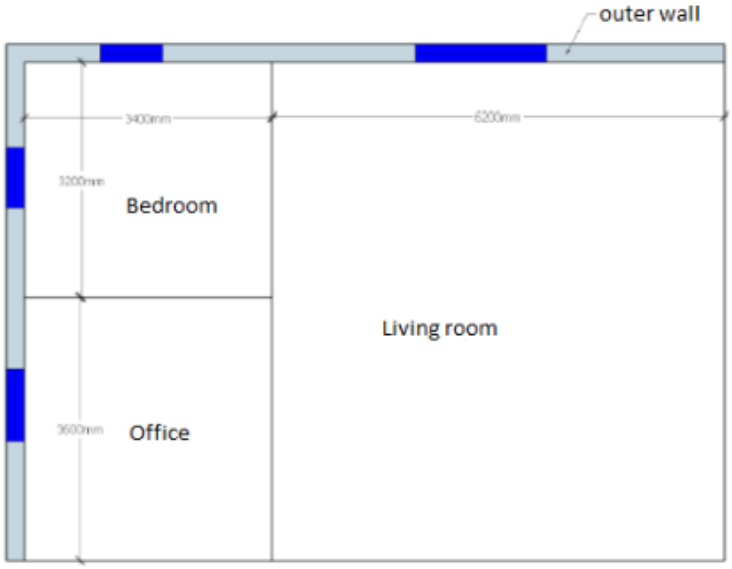
THE TASK

Your friend, who is not very good at physics, comes to you with concerns: his grandmother is on the board of the apartment association, and their apartment building, built in 1988, was selected for the "Old Apartment Building Energy Efficiency" program. The grandmother, however, does not agree, because she thinks that there is no benefit from the repair work being carried out. Your friend asks you for help in order to prove the usefulness of the work being carried out by calculation and to make it clear to the grandmother why the repair works should still be in favour.

1) The first planned work is the insulation of the external walls. The new outer wall construction will be: 150 mm concrete (λ = 1.8 m*K/W), 250 mm mineral wool (λ = 0.035 m*K/W) and 70 mm wind barrier plate (λ = 0.042 m*K/W) with finishing. Find the U number of the new structure.

2) In addition to insulating the walls, the windows of the apartment will also be replaced, you can read from the project that for the new windows U = 0.7 W/m2K. Calculate how much less energy it would take to heat your friend's grandmother's apartment with a new insulated wall and new windows in the winter with an outside temperature of -20 °C, if the grandmother wants to keep the room at +25 °C.

U for the existing wall is U = 2.45 W/m2K and for the old windows U = 3.4 W/m2K.

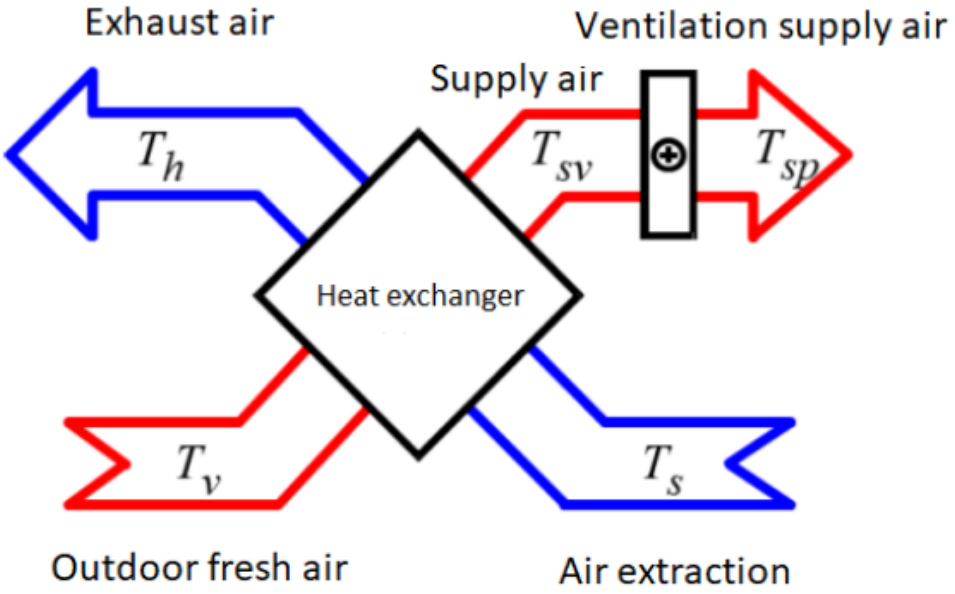


Scheme No. 1. Simplified diagram of the apartment.

3) To ensure sufficient clean fresh air, a separate ventilation system is installed in each apartment. Your friend's grandmother thinks that it is enough to simply have fresh air valves and mechanical extraction (there is no heat recovery), but the designer has foreseen a ventilation unit with heat recovery. In both cases, the airflow rate for the whole apartment would be 60 l/s. Unfortunately, the project does not specify the model of the apartment-based ventilation unit or any other information.

Air density is 1.2 kg/m3, specific heat is 1000 J/(kg·°C)

- Find a ventilation unit on the Internet that could be suitable for this apartment, briefly justify the choice, and state its efficiency, i.e. the heat recovery ratio. (Hint: a good search term is a fan unit with heat recovery, you can search for manufacturers such as Systemair, Save series, Komfovent Domekt series and Airobot).
- Calculate the temperature of the supply air (Tsv in the diagram) after passing through the heat exchanger, if the outside air temperature is -20 °C, the temperature of the air extracted from the room is +25 °C, and the heat recovery ratio is the value of the device found on the Internet. (If the device was not found on the Internet, take the value as 0.75)
- Find the capacity of the heat recovery device to show the grandmother how much energy the heat exchanger gives from the extracted air to the incoming air and to justify the necessity of a ventilation device with heat recovery.
- How powerful must the post-heating calorifier be in the ventilation unit (box with a plus on the diagram) to ensure the temperature of the air blowing into the room is +23 °C at the amount of airflow specified in the project?



Scheme No. 2. The working principle of a heat recovery unit with a post-heating calorifier