THE FORMATION OF FLUIDIZED BED HYDRODYNAMIC STRUCTURE, OPTIMAL FOR BURNING OF LOW-GRADE COALS AND BIOMASS

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Problem Formulation

- The hydrodynamic structure of fluidized bed is far from uniform and gas bubbles would rise along certain preferred lines. With regards to combustion of fine solids fuels and solid fuels with high volatile matter content, the formation of preferred gas bubble ascent lines can lead to burning of fine solids particles and gas flare formation that penetrates the bed and burns chaotically in the freeboard.

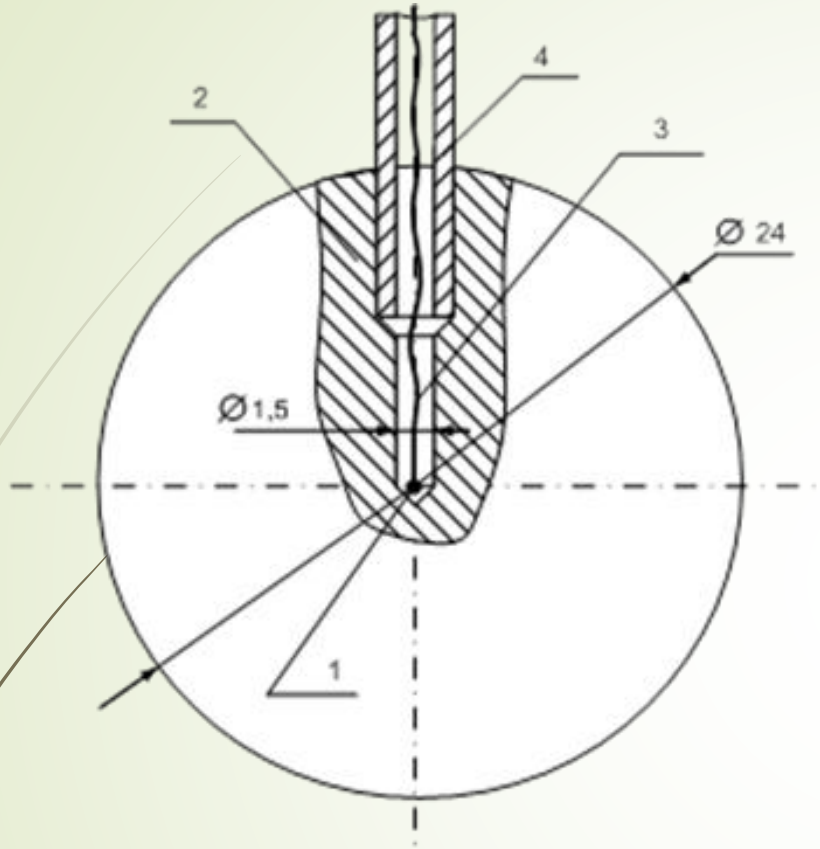


Diagram of sensor for determining heat exchange rate: 1 – thermocouple head with diameter of 1.2 mm, 2 – copper ball, 3 – thermocouple cables, 4 – connecting tube with diameter of 3.0 mm

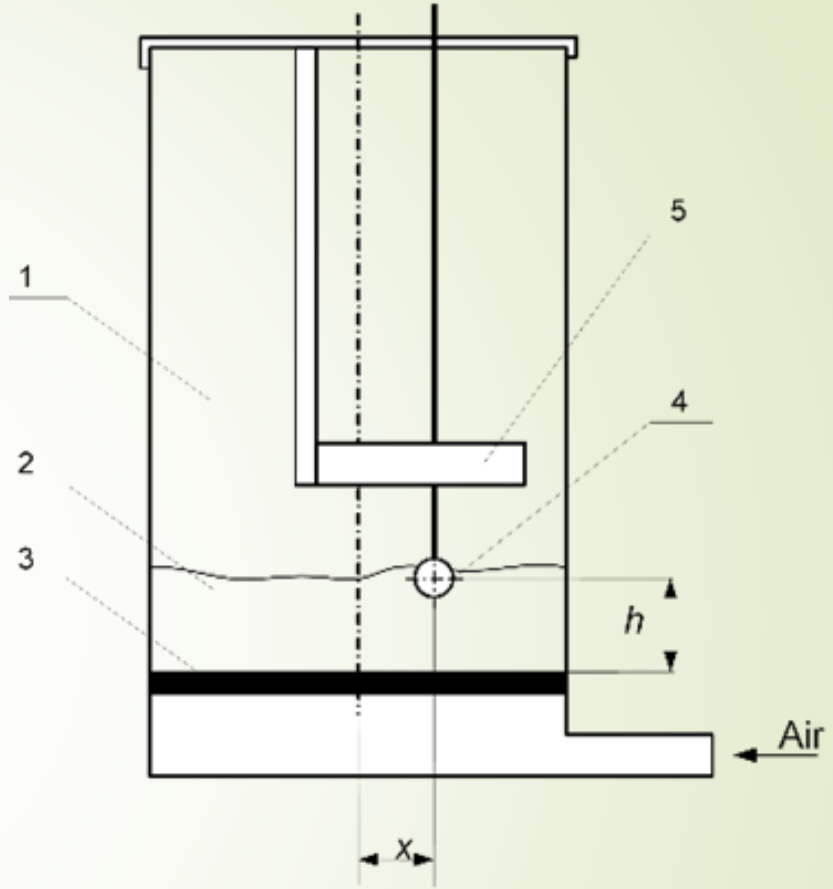
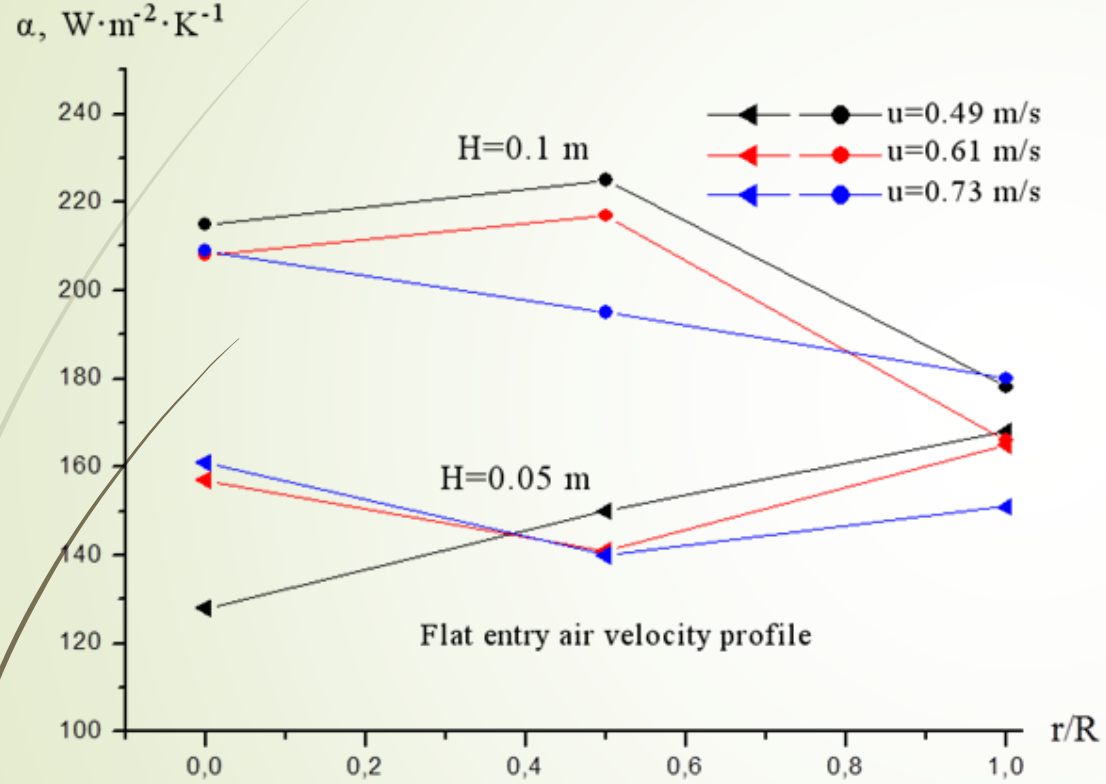


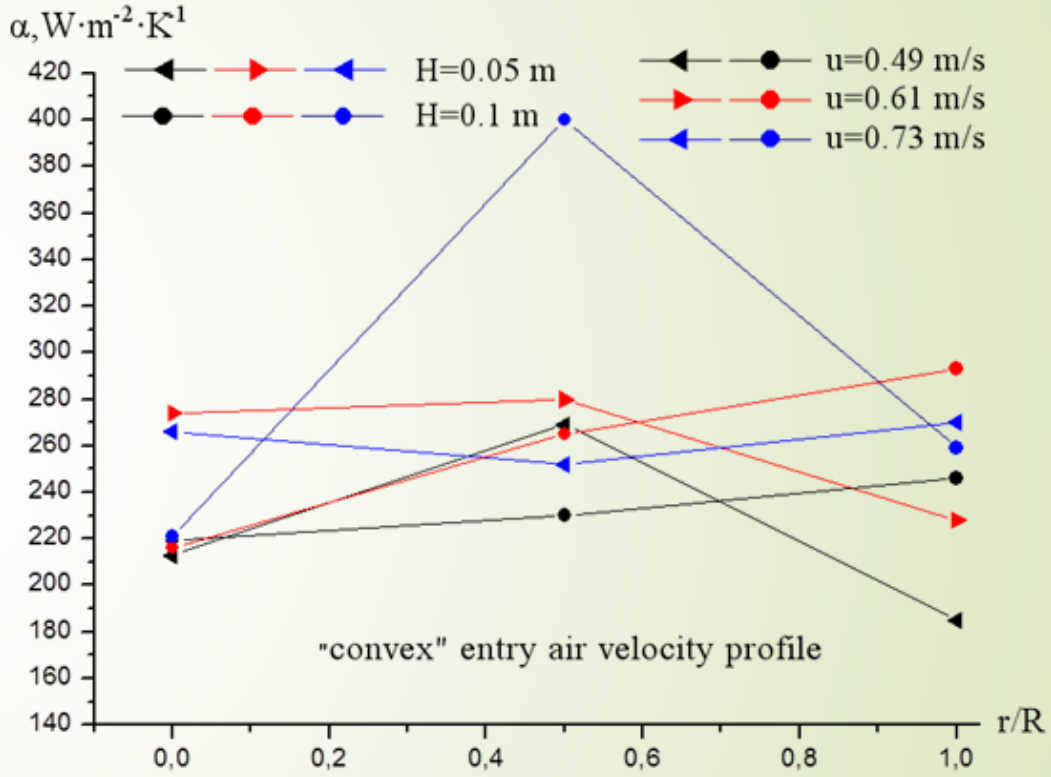
Diagram of sensor arrangement for measuring heat exchange rate in a fluidized bed.
1 – chamber with fluidized bed, 2 – fluidized bed of sand, 3 – gas distribution lattice, 4 – sensor, 5 – sensor positioning system

Problem Solution

- Particle movement in a fluidized bed can be affected by providing non-uniform entry gas distribution through a distribution lattice.
- The approach of providing intensive internal particle circulation in the bed by means of irregular air entry distribution is the simplest and solution. However, results of systematic studies of hydrodynamic structure of fluidized bed with the purpose of discovering optimal air entry distribution in the contex of combustion of fuels with high volatile matter content are not yet available.

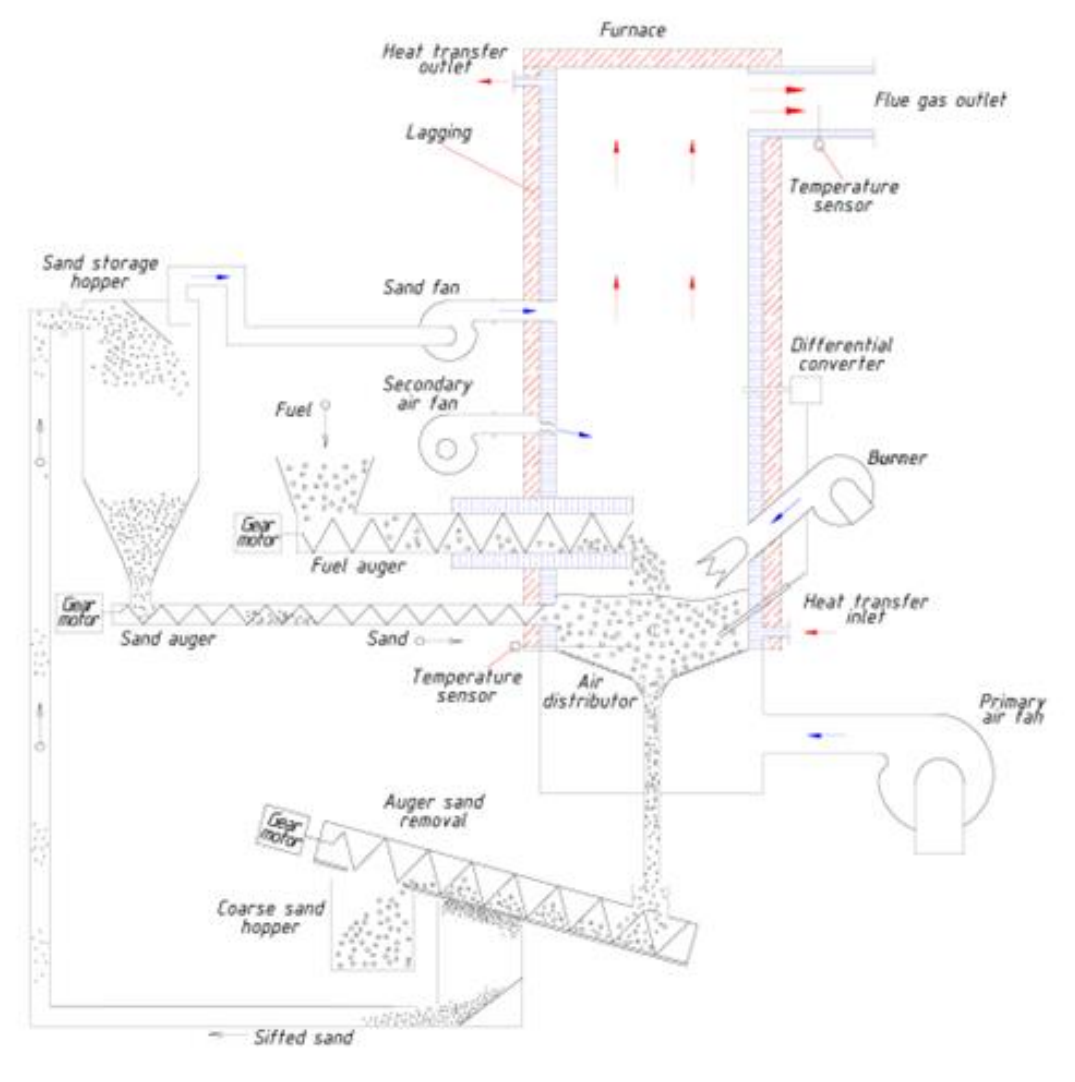


Heat exchange coefficient values between the fluidized bed and the heat exchange member plotted against air velocity at uniform entry air distribution (Flat entry air velocity profile).

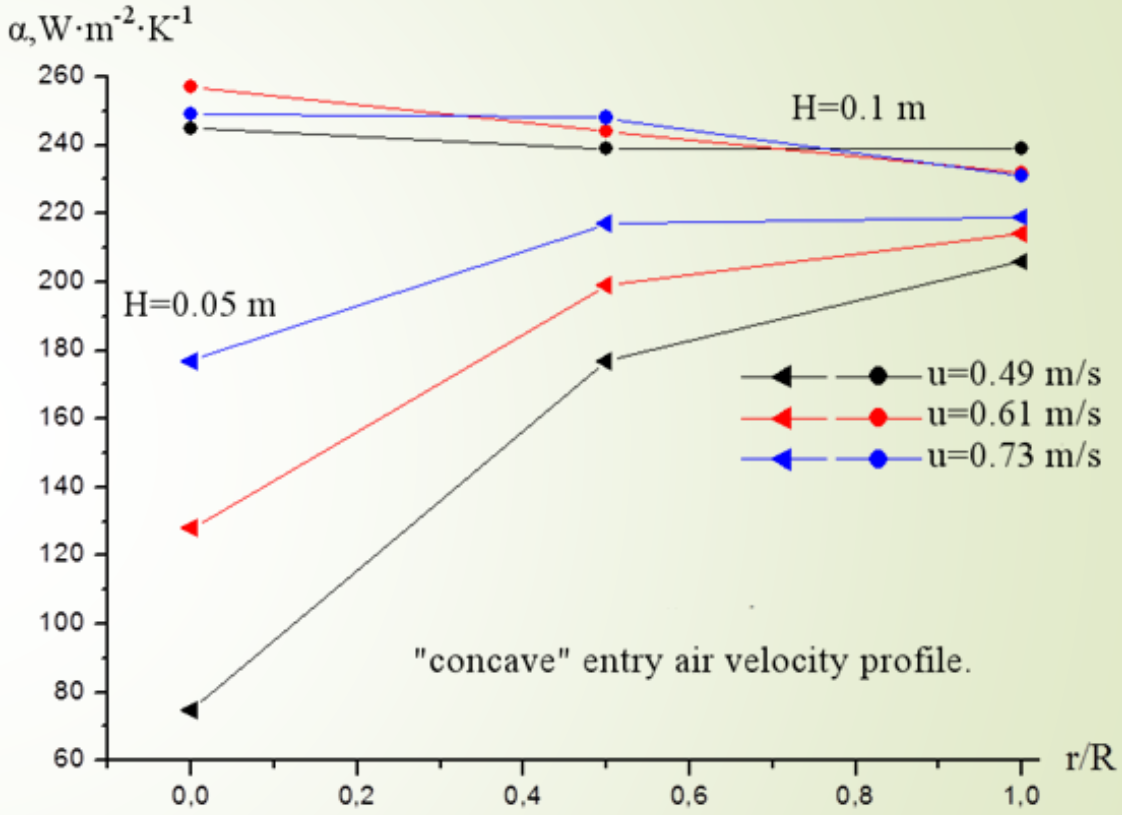


Heat exchange coefficient values between the fluidized bed and the heat exchange member plotted against air velocity in a "convex" entry air velocity profile.

Results and discussion

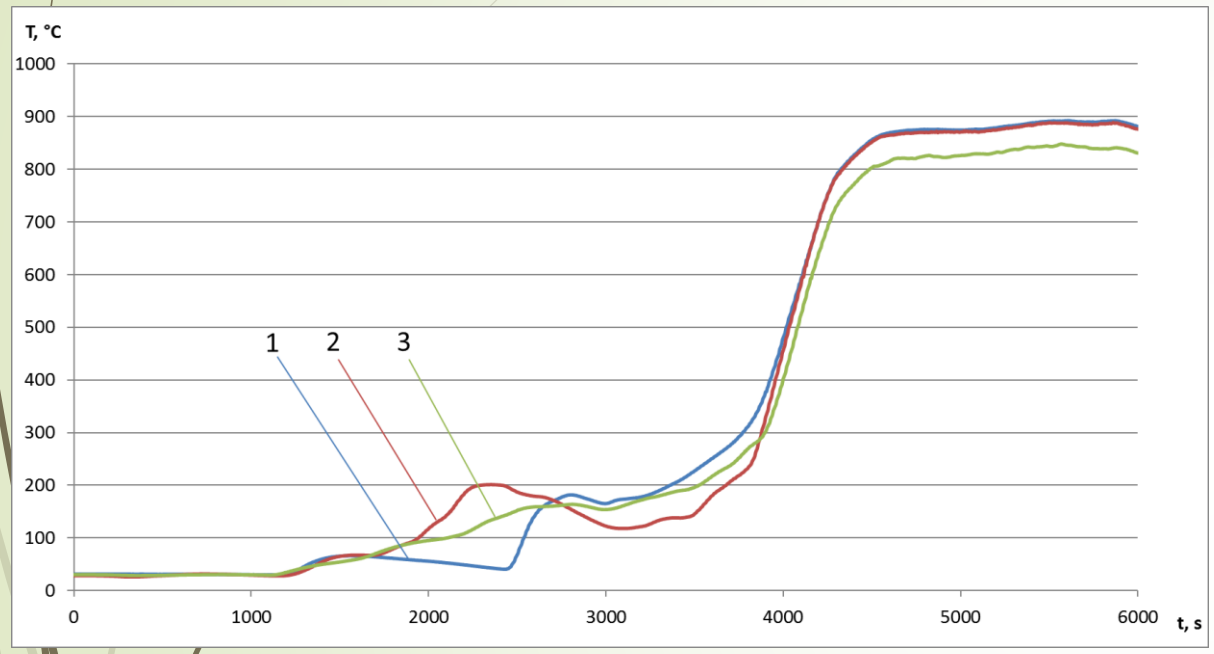


Functional scheme

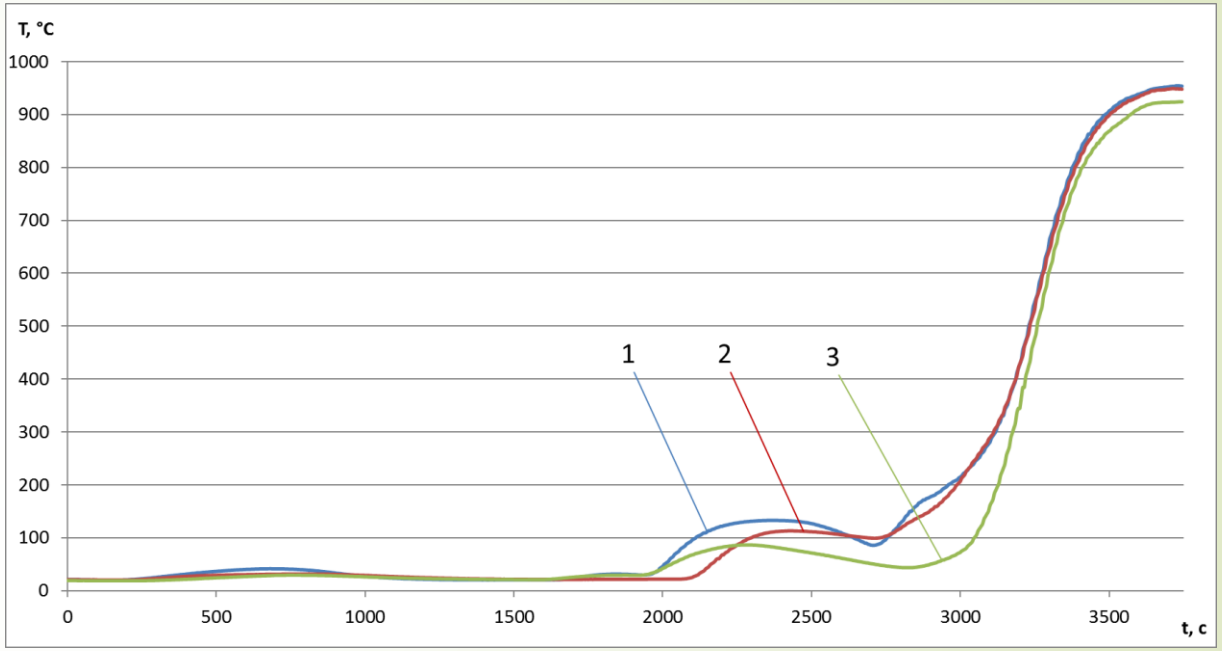


Heat exchange coefficient values between the fluidized bed and the heat exchange member plotted against air velocity in a "concave" entry air velocity profile

Experimental verification of results in practice



Changes in the bed temperature above the air distribution grille when igniting furnace for combustion of anthracite culm (1 - at a distance of 330 mm from the inner wall of the furnace, 2 - at a distance of 160 mm from the inner wall of the furnace, 3 - at a distance of 90 mm from the inner wall of the furnace)



Changes in the bed temperature above the air distribution grille when igniting furnace for combustion of straw pellets (1 - at a distance of 330 mm from the inner wall of the furnace, 2 - at a distance of 160 mm from the inner wall of the furnace, 3 - at a distance of 90 mm from the inner wall of the furnace)

Conclusions

- The conducted studies of changes in the values of local heat transfer coefficients in a fluidized bed allowed choosing the optimum type of air entry distribution for combustion solid fuel with high volatile matter content and solid fuels with small particles.
- The selected type of air entry distribution supplying the major portion of air near the furnace wall provides intensive circulation of solid particles and gas in the bed.
- This intense circulation provides almost complete combustion of the volatile matter in the bed volume and low emissions of carbon monoxide in the atmosphere by burning biofuels.
- On the other hand, the intense circulation of particles in the bed creates conditions for stable ignition and combustion of anthracite culm, which is low reactivity and high ash fuel

Acknowledgments

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Thank you for attention!