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PROBLEMS OF INDUSTRIAL AIR EXHAUSTING

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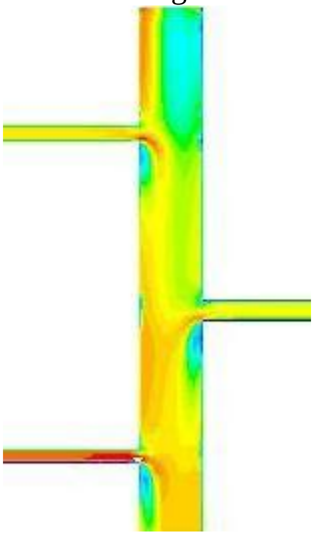
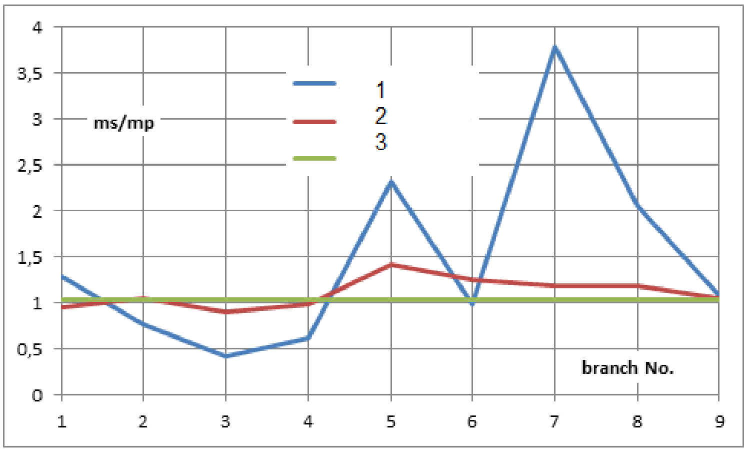
The correct operation of industrial equipment at high-quality, reliable and economic production needs the exhausting of prescribed (projected) air volumes from several branches into one common exhaust fan. To obtain an optimum tuning of the whole system, it is necessary to tune many parameters (branch diameters and resistances, i.e. throttling flap settings, total exhaust), when volumes and lengths of branches are fixed and fan cha racteristics is given.



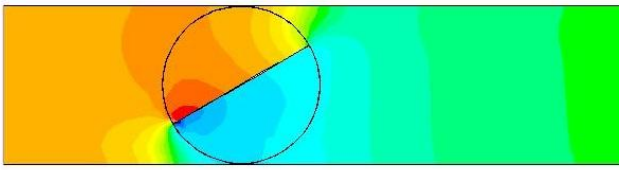


Results of the flow numerical simulation in such system show that exhausted volumes from individual branches are not equal to the projected one. Of course, higher volumes (relatively to the projected ones) could be reduced (throttled) by regulating flap, but smaller volumes must be magnified. To get the exact solution, it should be to use flow numerical simulation of such system to catch exactly all so-called local loses, usually defined by a losing coefficient, only. Really, the flow disturbing by such local lose is spread along specified tube length – on the left figure see the example of the velocity field for three neighbouring junctions, where the flow from the previous one influences the next flow(s), too. In a complicated system with more branches one by one, the individual branches are mutually affected, so that a simple calculation is not suitable due to significant errors of flows, resistances etc.

Graphs on the right figure present results of the optimizing process, received by flow numerical simulation. On the x-axis there are individual branches signed as 1 to 8 and the common outlet 9, on the y-axis there are ratios of flows (ms/mp = simulated to projected).

The line 1 presents the actual situation with considerable differences between simulated and projected values. The line 2 presents better result of the next step, when diameters of some branches were corrected. And the line 3 presents the ideal optimized situation (the value slightly over 1) after necessary tuning of some individual branches by regulating flaps.

The relation between the flap position and its flow resistance is obtained from numerical simulation of the flow through tube with inserted flap in specific positions at given tube diameter and flow volume. As an example see the next illustration of pressure decreasing in the flow around the flap in any inclined position.



All presented results are valid for so-called „hard source“, only. In the real operation the pressure difference of used fan depends on the air volume, where the flow resistance of piping system is typically equal to the quadratic function $\Delta p = f(V, V^2)$ and the fan characteristics could be typically used as another function. Real working point of the exhaust system is the point of intersection of both functions. To get this point, it is necessary to continue in the tuning of the system with reference to the relevant fan characteristics $\Delta p = f(V)$ or to change this characteristics, for instance simply changing the rpm.

The results received from use of this method were verified by field measuring with good coincidence. Now we can state that method of flow numerical modelling gives reliable results for reliable operation of the exhaust system.