

COGEN & COMBINED CYCLE APPLICATIONS: TEG AND FRESH AIR FLOW OPTIMISATION USING FLUENT

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1 - REASONS FOR FLOW SIMULATION

The room available for CH&P plants being limited, the changes of direction of TEG and fresh air ducts can lead to an uneven velocity distribution at the burner inlet, possibly resulting in :

- Hot spots on tubes, reduced tube lifetime due to an uneven temperature profile at HRSG inlet.
- Thermal loss of HRSG efficiency
- Pulsations
- Carbon deposits on the burner
- Increased emissions (NO_x, CO).

Increasing pressure drop is in no way an economical solution since it reduces GT efficiency.

Moreover, the cost for adding a fresh air fan and duct must be minimized and enable good air distribution without creating any disturbance when firing on TEG.

This shows that the investment and running costs of CH&P plants depend on mastering TEG and fresh air flow. Optimizing the duct shapes, lengths and connections using flow simulation allows to reduce costs and avoid operational problems.

2 - CHOICE OF THE BEST SOFTWARE

FLUENT® software (developed by CFD-Computational Fluid Dynamics) uses a mathematical method including step by step calculations; each step chosen according to each zone (fig.1). Two types of simulations may be used :

- 1 - Optimizing flows in TEG or fresh air mode upstream to the burner.
- 2 - Combustion flue gas flow lines downstream from the burner allowing to optimize the burner design, the shape of the connection duct, so as to obtain an even temperature distribution

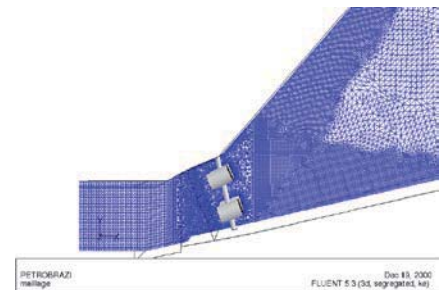


Fig. 1 - Mesh

3 - APPLIED EXAMPLES

One applied example is shown in figures 2, 3, 4, 5 a 108 MW PILLARD REBURNFLAM® gasduct burner (11 rows 6x4 m) TEG/fresh air. Since the available room was limited, the short fresh air duct was located perpendicularly to the TEG duct. The patented arrangement (PILLARD patent 00/15224) leads to an even fresh air distribution upstream to the burner. The vertical diffusers do not cause any flow disturbance nor pressure drop in TEG mode. The final velocity results are shown in fig.4: without applying a solution, discrepancy is +/- 80% (fig 3). With the (patented) design, such discrepancy is +/- 10%. The simulation performed on combustion flue gas allows to optimize the burner and to decrease the temperature distribution from +/- 200°C to +/- 50°C (fig.5). The costs of diffusers and perforated plates are almost negligible.

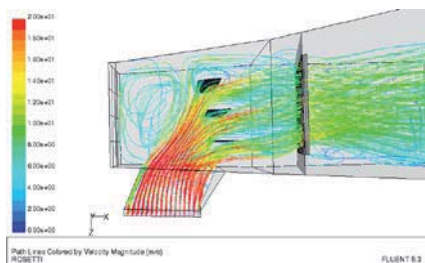


Fig. 2 - Deflectors

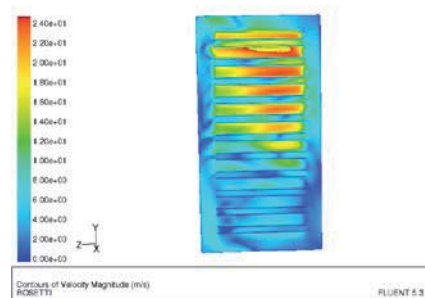


Fig. 3 - Before

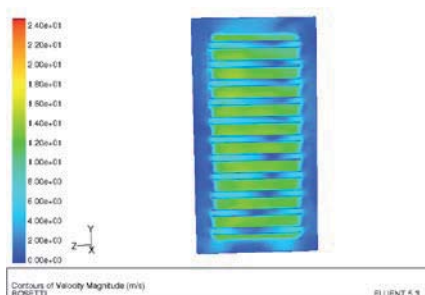


Fig. 4 - After

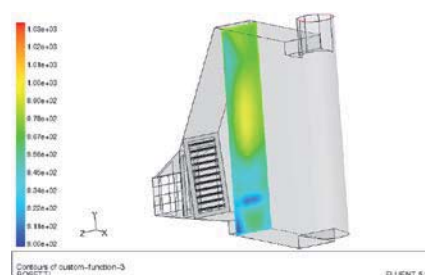


Fig. 5 - Boiler inlet temperature

Another example is shown in figures 6, 7, 8 : The PILLARD 22 MW REBURNFLAM® gasduct burner is located close to the GT outlet just after a change in duct section from cylindrical to square. The simulation allowed the solution shown in figure 7 to be developed, which enabled cancellation of rotation and improvement in flow stream distribution from figures 6 to 8.

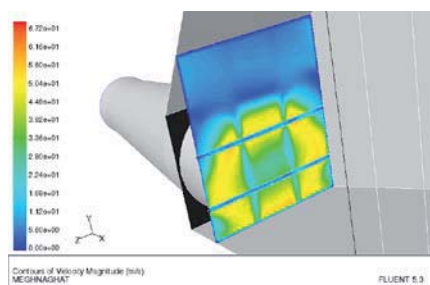


Fig. 6 - Before correction

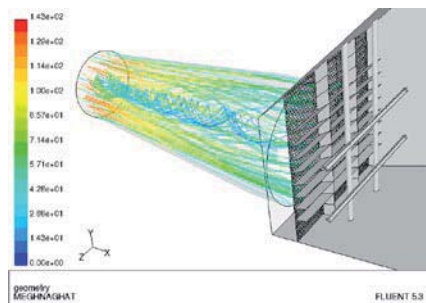


Fig. 7 - Deflectors+perforated plate

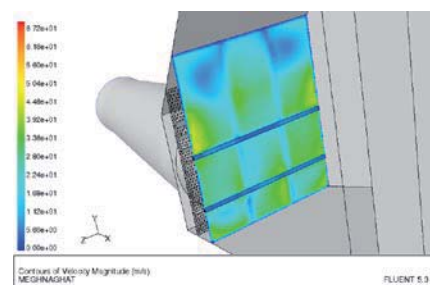


Fig. 8 - Final result

Another example is shown in figures 9, 10, 11 : the 4 x PILLARD 15MW GRC INDUCT burners, heavy-oil fired, are now firing with TEG much more smoothly thanks to flow optimization.

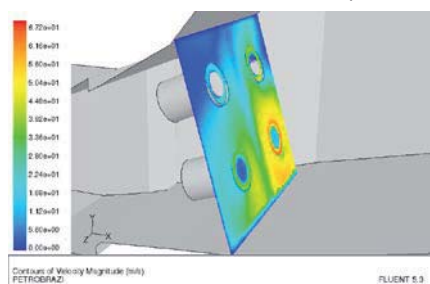


Fig. 9 - Before correction

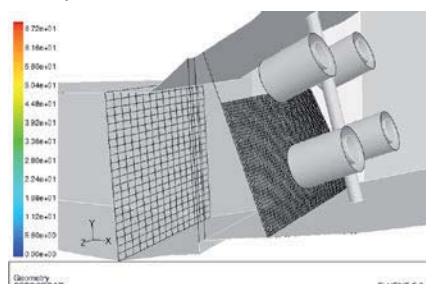


Fig. 10 - Double perforated plate

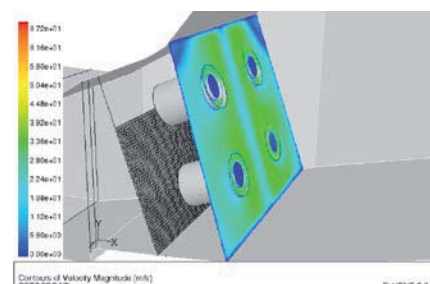


Fig. 11 - Final result

Another example is shown in figures 12 to 17. 40 x PILLARD 22MW GRC INDUCT burners, diesel-oil fired, equip 4 HRSG of the world's largest desalination Plant FUJAIRAH (U.A.E.). Firstly the velocity distribution has been improved (fig. 12, 13, 14). The combustion simulation has been exploited to optimize the burner head position and orientation in order to reduce the temperature discrepancy at HRSG 's inlet to +/- 80°C (fig. 15, 16 and 17)

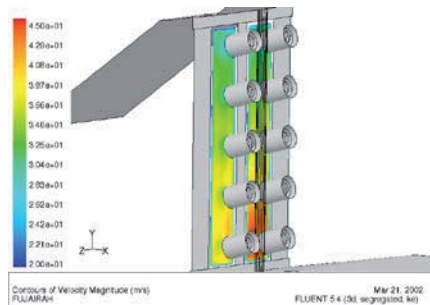


Fig. 12 - Before correction

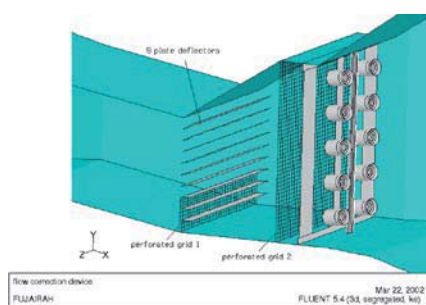


Fig. 13 - Deflectors + perforated plate

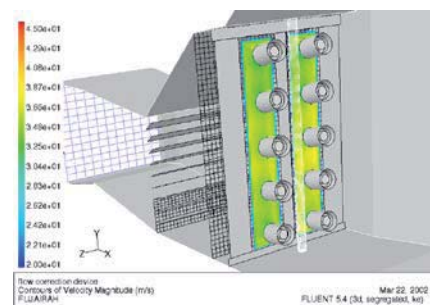


Fig. 14 - Final result

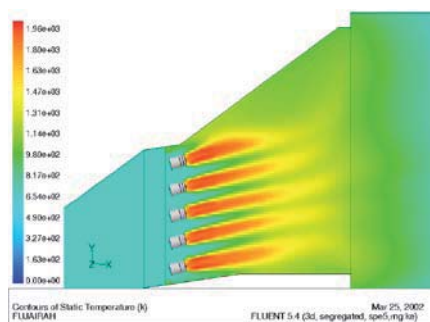


Fig. 15 - Temperature distribution (side view)

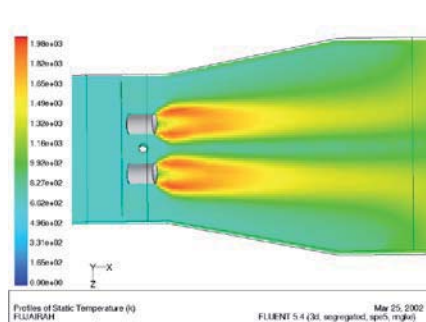


Fig. 16 - Temperature distribution (top view)

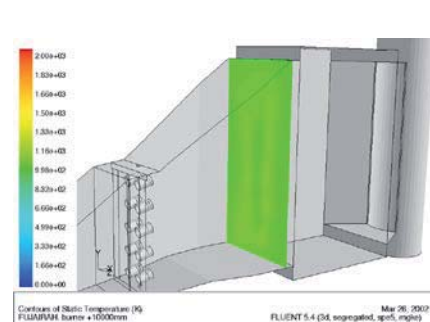


Fig. 17 - HRSG's inlet temperature distribution

4 - CONCLUSION

PILLARD'S application of FLUENT® flow simulation software to CH&P plants brings the following advantages :

- Reduced cost of TEG and fresh air ducts as well as a smaller space occupied by the plant
- Reduction of the plant running costs by improving the temperature distribution at HRSG's inlet cross section, and limiting the pressure drop, both in TEG and fresh air modes.

Such techniques, now confirmed by much feedback from working experience, allows to give a better service to our clients and to promote the economical advantages of these types of power generating plants.