**Optimization of water mist system in refinery process**

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**Highlights**

* Development of CFD model and pilot plant based on the actual refinery process.
* Optimization of flow rate, number of nozzles and mist size.
* Reduction of the number of nozzles (20%) or amount of water (25%).

**1. Introduction**

At the CCR/Platforming process, which is operated by commercial refinery company, heat exchange is performed using an air-cooled heat exchanger. Unlike a water-cooled heat exchanger, an air-cooled heat exchanger uses air for heat exchange. Therefore, it is affected by ambient air temperature. Especially in the summer, when the temperature is high, a problem occurs that the heat exchange efficiency is reduced.

To solve this problem, many refinery companies are using water mist system. Water mist system is that sprays water finely to absorb heat in the ambient air. However, there is a problem with this system. That is, the corrosion of refinery device because of spraying excessive water.

In this study, we developed the CFD model to find out variables that affect water mist system and optimize the water mist system to solve the problem.

**2. Methods**

2.1 CFD modeling

|  |  |
| --- | --- |
| Simulator | Star CCM+ v12.04.011 |
| Analysis time | 60 seconds |
| Computational time | 144hours/case(CPU 2.1GHz 64GB RAM) |

The flow analysis model was developed based on the actual operational process using computational fluid dynamics (CFD). In this model, Lagrangian analysis and unsteady state flow conditions are simulated. There are 8 fans (2 fans/1 set) and 640 nozzles (80 nozzles/a fan) in the actual process. The CFD model is develop with 1/2 fan and 40 nozzles.

**Figure 1.**  CFD model of water mist system.

2.2 Pilot plant configuration

We made a pilot plant to observe the cooling effect of water mist system. The size of pilot plant is 2165mm (length) x 1670mm (width) x 2543mm (height).

**3. Results and discussion**

3.1 CFD simulation results

Table 1 shows two results. First, when the number of nozzles is decreased by 20%, the cooling effect increases by 6%. Second, when the total flow rate is increased by 16.7%, the cooling effect increases by 23.1%.

**Table 1.** Result of CFD simulation.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Case | Number of nozzles | Flow rate per nozzle | Total flow rate | Cooling effect [K] |
| **1** | 64 | 15L/hr | 960L/hr | -9.31 |
| **2** | 80 | 12L/hr | 960L/hr | -8.78 |
| **3** | 14L/hr | 1120L/hr | -10.81 |

3.2 Pilot plant test results

Table 2 shows no difference between nozzle A and B of cooling effect. Although the total flow rate of nozzle B is about 75% of nozzle A, they have almost same cooling effect. Because water mist size and distribution of nozzle B is smaller and better than nozzle A.

**Table 2.** Cooling effect by operating pressure.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Input [K] | Output [ΔK, 30bar] | Output [ΔK, 40bar] | Output [ΔK, 50bar] | Output [ΔK, 60bar] |
| **Nozzle A** | 387.15 | 45 | 45 | 45 | 45 |
| **Nozzle B** | 45 | 45 | 45 | 46 |

**Nozzle B**

**Nozzle A**

**Figure 2.**  Water mist size by pressure.

**4. Conclusions**

We developed CFD model and optimized water mist system in refinery process. Pilot scale experiment for water mist system is conducted to find out mist size distribution and cooling effect depending on the nozzle A and B. Finally, we reduce the number of nozzles by 20% or amount of water by 25% to optimize the water mist system.

**References**

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