

## Header Flow Maldistribution - *Can it hurt you and do you know it?*

**Y**ou are walking out into B complex just recently built, at your petrochemical complex. Complex A has been running for several years with no problems. In fact, it was running so well, that management elected to duplicate complex A for the design of complex B. But, as always, the new plant offered an opportunity to debottleneck a few areas and realize the maximum capacity and efficiency of the unit. This makes the bean counters happy, and the project just squeaks by for approval. Here comes the project team - all ready to achieve goals and objectives. In the new process, a header feeds four boilers. One of the boilers failed and you are wondering, how can this be, it is a sister unit with all the same major equipment.



Your materials group has said the problem is low cycle thermal fatigue causing the failures and your process group says everything is o.k. The material is the same as being used in complex A. All the experts in every area are telling you there are no problems and the unit should not

fail. Some experts are concluding that it must be the operators letting the process swing through a transient too rapidly. The operators are angry because they know they have been operating the plant right and the plant manager is breathing down your neck, just as everyone is telling you there is nothing wrong with the design.

Although, the plant A and B are sister units, the only difference is the feed rate has changed by only 10%, but it is still within the boiler's name plate, with room to spare. What could be the problem? While sitting in your front office watching the sprinkler system come on, it hits you. You have always observed some of your sprinkler heads being starved because of an insufficient header size. What about the feed header at plant B?

Well, as it turns out the problems were caused by a header maldistribution, due to the header configuration and flow. Process calculations showed that based on the frictional pressure drop, the header should be O.K. But, CFD showed that the dynamic head recovery in the header was high enough to cause a maldistribution. Once a certain flow was reached, this

maldistribution would starve certain parts of the system, causing system overheating.

Header design is important for all kinds of process equipment such as pumps, compressors, and heat exchangers. There are general rules for sizing headers that work well, depending on fluid velocities and density, but consider the following.

1. Layout the design in accordance with normal process guidelines.
2. Position the inlet in the most strategic and symmetrical location.
3. Calculate the frictional pressure drop and the dynamic head. Make sure the dynamic head is not a detrimental player.
4. Perform a computational fluid dynamics (CFD) study of the header to validate the design. Make any changes required. The CFD study will account for total flow conditions including local inertia effects.
5. Have the design reviewed by a professional engineer competent in header design.

### ***KnightHawk Project Update***

- Transient Heat Transfer FEA – Refinery
- Axial Compressor Analysis – Petrochemical
- TLE inlet aerodynamics - Petrochemical
- TLE Failure Analysis – Petrochemical
- Pelletizing Die Design Second Order – Petrochemical
- Piping Acoustical Vibration – Petrochemical
- Furnace Design CFD – Petrochemical
- Exchanger Failure – Petrochemical
- Pipe Stress – Refinery
- Structural Dynamics – Rotating Equipment - Petrochemical
- TLE Coking Analysis – Petrochemical
- Piping Failure – Refinery
- Pipe Stress – Refinery
- Secondary TLE analysis – CFD, FEA, Custom Software Petrochemical
- Structural Dynamics – Petrochemical
- Rail Car Failure Analysis – Petrochemical
- Ball mill Analysis – Petrochemical
- Waste Heat Boiler Failure Analysis - Petrochemical

### ***Cliff's Notes:***

**O**ur team at KnightHawk has solved many header problems using the CFD tool, and our experience. Many have involved rotating equipment that had caused long term headaches.

**T**he other day I had jury duty for the first time in my career of 22 years. I had always gotten out of it, being out of the country, some other problem, etc... Not this time as Texas, especially Houston is tough on this. So begrudgingly I went, as I had no choice. I had so much to do and I was so afraid I would get stuck on some murder trial in which I would devote all my energy, because of the responsibility. I went to a big room where we all waited and waited. I had time to reflect. I remember my father and uncles in combat in World War II, my cousins in Vietnam, our troops in Afghanistan, and all that had died and sacrificed just so we can have this great system of justice. I had a complete change of heart that day and was glad to be there. I then went to a courtroom and was interviewed for a short case. I won't tell you whether I was chosen or not, that's up to you to guess.

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