Core principles

"If you can't take the heat, get out of the kitchen" is well known, but for engineers, the kitchen is the labor, the shop or the plant, namely the place where ideas meet the realities of the world. And there is always heat!

Heat is rejected in every work process, materials lose strength as temperature goes up (due to too much heat), lost heat reduces the performance of a turbine expansion process but helps the appearance of a good compression process. Oil properties in a bearing change with temperature (some for the better, some not), cooling systems must be designed to reject excess heat properly, and the list goes on. The reader can no doubt recount even more challenging heat problems from his own experience.

Every mechanical or chemical engineer, and various others as well, can easily remember taking courses in thermodynamics and heat transfer. In many cases, the courses may have started out seeming dry and abstract, but most engineers discover within a few years of practical experience that they can't escape any real world problem without understanding its temperature and the heat balance on the operating system that leads to the specific thermodynamic state.

If only we could have had a clearer understanding in college of just how common thermal issues are in practice, then we might have drawn more out of the textbook lectures! This writer, as a frequent lecturer, often has to stop and review such basics for students wishing to study any class of turbomachinery, due to a fuzzy recollection of the core principles.

Interestingly, looking back historically, one sees just as much confusion in the early research into thermodynamics while the basic principles were being researched and laid out for future engineers. I have been reading "Degrees Kelvin" by David Lindley, which gives the life history of one major player, Prof. Thomson, who subsequently became Lord Kelvin, for whom the Kelvin temperature scale is named. He is only one of many who struggled and teased out diverse aspects of thermal nature and then crafted them into the laws of thermodynamics and accompanying principles. This book is a great read for the serious student who wants to see the difficult history that we have passed through to arrive at modern thermodynamics; others may want to avoid the book.

Most engineering work today is sensibly thought out through a typical development cycle, but there are still too often basic errors made in applying core principles, ones which simply cannot be violated. In recent years, I have seen common errors made in temperature, pressure, and flow measurements. (Quiz: How do you deduce static temperature in nature? How is a good static pressure measurement made? How accurately can you measure flow with an orifice, and what are the PTC10 installation requirements?)

Also, I have seen gross errors made in efficiency reporting by failing to understand the complete heat flow involved including phase change issues. (Quiz: Can humidity seriously affect reported efficiency?) And frequent oversights occur when rotordynamic or structural failures occur, only to find out that the components were operating at a different temperature than expected (read — heat, again).

Since such heat-related matters occur with surprising frequency, it seems likely that we haven't gotten enough out of our college courses, or that we don't take enough time to work out all the consequences in advance. Either way, it breaks down to good training.

So perhaps it is time for a good review; you have many choices. You can dust off the old college textbooks and reread vital sections, but this may be tedious. You can audit a good course at a nearby college and really use the advantage you now have with worldly experience to ace the course and get a lot more out of it — or better yet, offer to teach the course and you will really become proficient. Another good option is to continue your turbomachinery education with specialist courses that force you to rethink your college thermo and heat transfer. *Note: This author regularly teaches such courses which are publicly available.*

So the heat is on! Are you really proficient in practicing the thermal and fluid sciences, or is it a good time to review before things get unbearably hot?

Post Script: This author is occasionally asked to testify in court on performance matters of turbomachines; the core problems encountered are invariably of the nature described above. The court room is a really bad place to sort out one's basics! TI

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