REFRIGERATION REVIEW

Monday, April 20, 2020

Critical Gas Flow

Critical gas flow is a phenomenon that is a little difficult to understand. Molecules of air vibrate on average at the speed of sound, as do gases at their own unique velocity for the size and weight of the molecules they represent. So long as these molecules have something to "bump" against, a wall or other molecules, they do their little vibrating dance according to the molecular theory of gas. If you can imagine: you have an invisible wall, and you removed all the molecules instantly from a solid wall of molecules, and could hold them for a split second, somehow, and then release them – what a thunderbolt occurrence that would be! Guess what? That's exactly what thunder is – lightning slices an instant void in the air, and all of a sudden those molecules come banging back together with such a

jolt that it causes thunder. Now, if you take this model inside a piping system that has refrigerant gas in it, you can simulate these conditions by the well-known critical pressure ratio, which basically says that if the pressure in one area of the pipe is half of what the pressure is in another area of the piping system, regardless of how far apart they are (keep in mind these molecules are hell-bent on traveling at the speed of sound), the critical pressure will induce the gas to go the speed of sound. As the pressure wave gets started, you would think, "It's going to hit other gas," because the other gas is now slightly pressurized. That pressurized gas says, "I don't want to be a gas anymore, I want to be a liquid." In the case of ammonia, that ratio could be 800:1. So basically, the gas is looking at an invisible wall and trying to approach the sonic speed of molecules – for air, 750 mph, but for ammonia it would be slightly different. As it progresses, it creates a liquid cannonball whose weight doesn't have to be very much to blow apart a 6" ell or cap at the end of a line, as has been observed on more than one occasion. So, especially with a refrigerant at relatively low pressure, like ammonia, care has to be taken in designing defrost control groups and piping systems that use surge drums to minimize gas and slugs of liquid that can be propelled at sonic speeds.

It is noteworthy to mention that CO_2 as a refrigerant is not nearly as susceptible to critical flow conditions because its operation is normally at much higher pressure and the 2:1 ratio would be almost

impossible to achieve in the gas and liquid state. As is well known, if released to the atmosphere, CO_2 would go immediately to the solid state of dry ice.

The result of Critical Gas Flow in an Ammonia Refrigeration System