REFRIGERATION REVIEW

ANNULAR FLOW

For many years, design engineers and contractors have used abbreviated refrigerant tables for determining pipeline sizes. The use of “cookbook” pipe size selections and the installation of piping systems with two dimensional or flow diagram drawings have been invitations for unpredictable flow in movement of liquid and gas in refrigeration piping systems. Large systems using remote surge drums for flooded evaporators or remote recirculating tanks or vessels have been causes of liquid slugs as gas expands behind columns of trapped liquid. Multiple slugs of liquid are of particular concern where gas pockets could condense rapidly causing thermoshock and where the impacts of liquid slugs can overstress pipe and valve components when abrupt turns or stoppage occur. Flow formation types are shown below in Figures 1, 2, and 3.

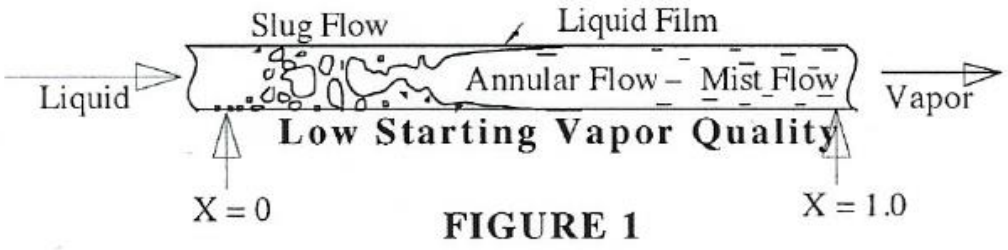


FIGURE 1

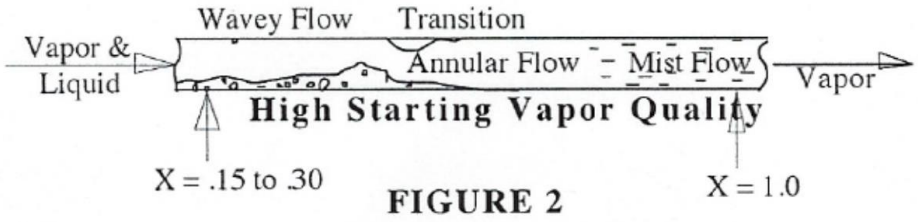


FIGURE 2

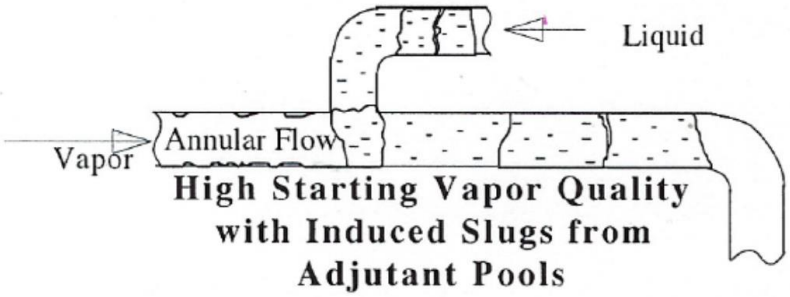
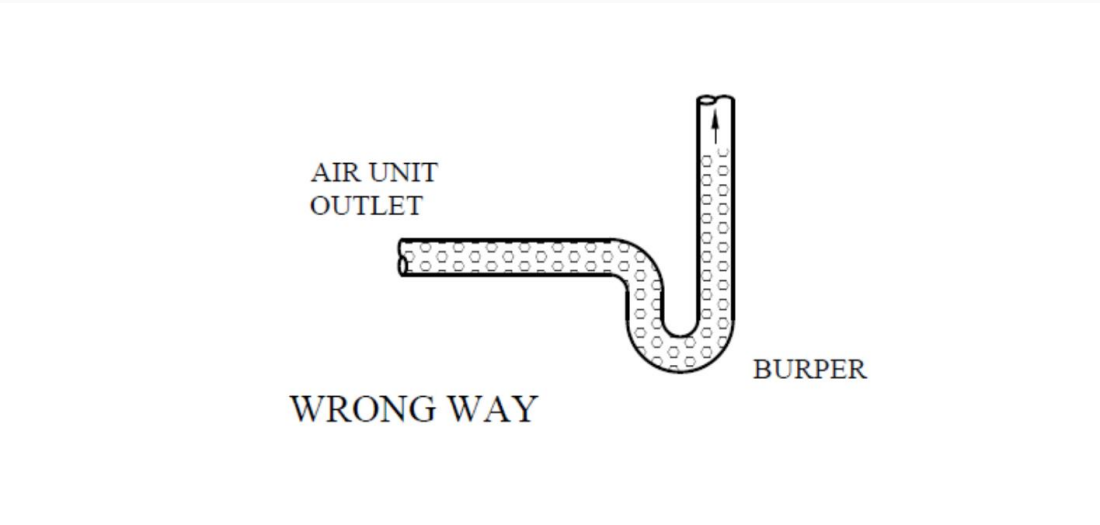


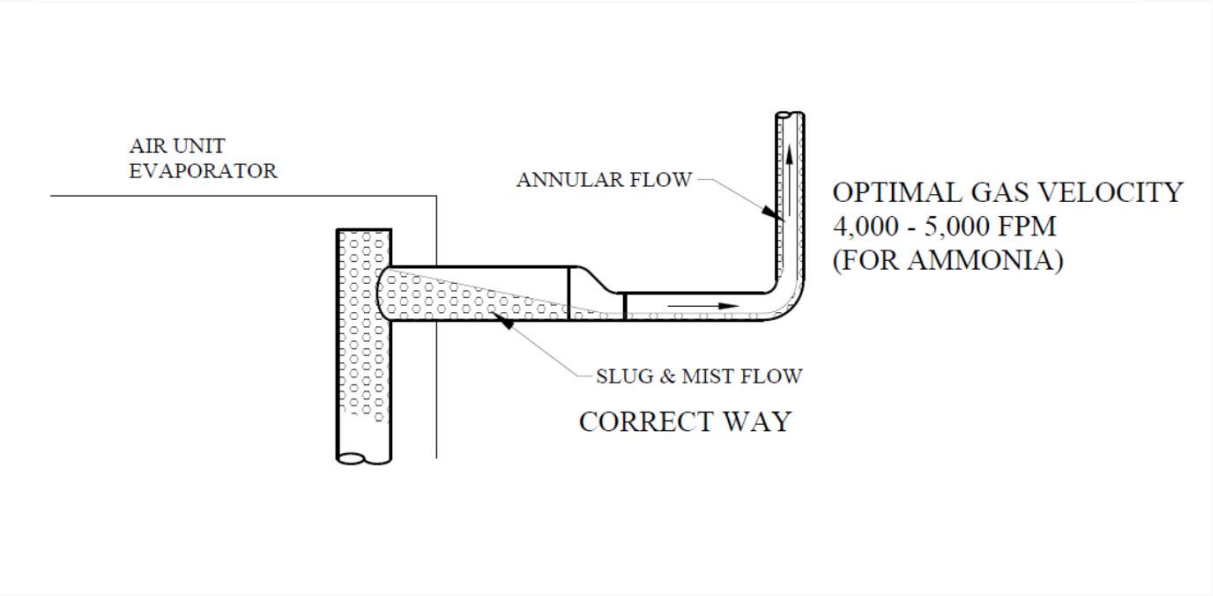
FIGURE 3

The number of significant failures in refrigeration piping systems is estimated to be in the range of 15 to 20 per year. The most critical are those which cause major floodbacks to machinery room and compressors. Generally, these failures

are associated with improper application of control valves, sequencing, or fail-safe positions on control valves (particularly valves in the suction lines). In addition, I bring attention to unique piping such as thermosyphon, which requires a significant understanding of two-phase fluid flow. The primary concerns are for life safety, environmental hazards, and minimizing production interruptions in storage and processing facilities.

One of the primary areas that are misunderstood are the suction lines leaving evaporators, particularly evaporators that are located below the branch or main lines and require vertical risers. With direct expansion (DX) valves, traps are necessary to position the thermal expansion bulb so that it can pick up superheat conditions without being influenced by liquid refrigerant and oil. There is absolutely no need for a trap with recirculated liquid – in fact, it is detrimental in getting the velocity up to the 4,000 to 5,000 fpm necessary to annularly lift liquid up the riser. This is why an eccentric reducer helps in this process, whereas a concentric reducer would impede this process by creating a "reverse waterfall" and turbulent flow. The liquid would tend to organize itself at the lower part of the pipe coming out of the air unit, and thereby gain velocity through the eccentric reducer as it hits the ell to go vertical. So, you want the velocity to be as high as possible before it hits the 90° ell that turns vertical, and after it turns vertical, you don’t want to impede it with other ells. Worst case scenario is if an offset is necessary, it should be done with 45° ells and not 90° ells. Then, as has been previously discussed, an inverted trap should be provided to prevent liquid from falling back down under low pressure conditions.





So, all said and done, you trap DX systems, you don’t trap recirculated systems.