Question 14: How do you ensure that the reactor effluent stream is evenly divided when going to parallel exchangers?

Michael Chuba (Sunoco)

Two phase reactor effluent flow to parallel exchanger trains need to be addressed during the design and initial piping layout phase. Once the system is installed very little can be done to evenly distribute the liquid and vapor. One can try to use valving to attempt to adjust the flow, but this typically results in a potential block-in case which could lead to the need of a high temperature relief valve on the reactor.

All of Sunoco units rely on symmetrical piping in units that have parallel exchanger trains with no major issues being noticed. If possible, the best design would have a straight horizontal run of 5 to 10 pipe diameters leading into the tee. Any elbow closer could lead to liquid preferentially accumulating on one side of the pipe entering the tee. This could result in uneven distribution of liquid in the tee.

As for liquid distribution, depending on degree of feed vaporization, a slight flow in- balance may or may not be that critical. In cases with a relatively high degree of feed vaporization a significant portion of the heat load is in condensing and not in sensible heat. In the case where 50% of the feed is vaporized, roughly 25% of the heat load is cooling the liquid. At 80% vaporization it drops to about 10% of the heat load. Thus, it becomes more of a vapor distribution problem.

For vapor distribution total downstream pressure drop up to the point where the streams are remixed becomes important. Thus, the corresponding exchangers in the parallel trains should be of identical design. If the exchanger train consists of multiple sets of stacked exchangers, it would be recommended that the flows be combined and re-split at the top of the succeeding set of exchangers.

On the feed side the liquid and vapor should be controlled evenly to the first exchanger of each train, if possible. This evenly controlled flow to each train should be kept separate throughout the entire preheat train.

Vern Mallett (UOP)

Splitting of reactor effluent material is accomplished via symmetrical piping from the common split to the common junction. In addition, the elbow upstream of the tee must be perpendicular to the run of the tee to avoid liquid favoring one branch over the other. Only one symmetrical split is allowed for reactor effluent material

Brian Moyse (Haldor Topsoe)

We have experience with two-phase flow using one reactor outlet feeding two feed effluent heat exchanger trains.

This is achieved using a long vertical pipe rise followed by a T-split. This is again followed by a

completely symmetrical piping and equipment arrangement up to the mix point of the two trains and works well.

The vertical piping is supported by the platform which holds the feed/effluent heat exchangers. The flow regime in the vertical piping should be annular-mist flow.

Dave Ferguson (Tracero)

An online method for diagnosing the presence of this problem is to use a radioactive tracer test. Using external radiation detectors the velocity of the tracer material is measured (volumetric flow can then be calculated) in each branch of the piping. If the piping diameter is constant, then single detectors (using the area under each detector curve for flow comparison) can be used which is an advantage if the piping is short after the split.

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