Technical Bulletin

TB# 58

The Effect of the
Second-Stage Homogenizing Valve

As a result of the development of sophisticated particle sizing methods, it is now possible to accurately measure homogenizing efficiencies for various valves, valve combinations and pressures.

In evaluating valve combinations, it has been found that with fluid milk and other emulsions at any given homogenizing pressure, efficiency is increased by the use of a second-stage valve; whereby, 10% to a maximum of 20% of the total pressure is applied by the second-stage valve.

In homogenization, as the liquid travels from the high-pressure zone in the cylinder through the area between the valve and seat, there is a large increase in fluid velocity and a corresponding decrease in fluid pressure. The fluid velocity initiates very intense turbulence in the fluid jet exiting from the valve and seat. This turbulence disrupts the disperse phase and produces the homogenization effect.

The additional use of a second-stage valve will serve to exert a backpressure on the fluid moving through the first-stage valve and, consequently, will influence the intensity of the turbulence by suppressing cavitation of the liquid. Cavitation of the liquid creates a two-phase flow of gas-in-liquid which makes the liquid “spongy”. Elimination of the cavitation enhances the zone of turbulence. With many emulsions the proper use of a second-stage valve will optimize the homogenization phenomenon. In some cases certain physical attributes, such as viscosity and appearance, can be better controlled.

Figure 3 demonstrates the effect of second-stage pressure. The vertical numbers on the left indicate the mean droplet diameter statistically weighted for the droplet-size distribution, as determined by a spectroturbidimetric technique. The numbers across the bottom shown as decimals are the second-stage pressure expressed as a percentage of the total pressure. At 2000 psi, 0.10 equals 10% of 2000 psi or 200 psi. This backpressure includes the second-stage pressure plus any downstream backpressure. At zero P2 (second-stage), 2000 psi total pressure, the mean diameter is about 0.83 micrometers. When 200 psi second-stage pressure is applied, the mean diameter becomes 0.65 micrometers. At 0.20 or 20% P2 (400 psi), the mean diameter is about 0.70 micrometers. As the P2 pressure is increased further, the mean diameter becomes larger. Therefore, there is no benefit in increasing the backpressure beyond the optimum value of about 10% because this will reduce the ΔP through the first-stage valve. **(NOTE: The second stage valve should not be operated at pressures greater than 500 psi. Exceeding this pressure will produce excessive wear in the second stage valve body, which, typically, does not have an impact/wear ring.)**

It has been determined that, when using a grooved valve on fluid milk (available on capacities of 5000 gallons per hour and above), there is a built-in P2 or second-stage pressure in the valve design. The use of an additional second-stage valve will provide a P2 exceeding 20% and a deterioration of the efficiency.

The recommendations on homogenizing ice cream mix are, of course, a two-stage valve with 10% on the second-stage. It is possible that some mixes, due to the formula, stabilizer content or viscosity requirements, may require more second-stage pressure. The Micro-Gap® homogenizing valve is installed with a restrictor to generate the correct backpressure for the operating conditions of the valve.

The restrictor and downstream equipment such as heat exchangers will all contribute to the total backpressure on the Micro-Gap valve. Figure 5 shows the change in droplet size with P2 for a simulated milk type emulsion on a Micro-Gap valve. This is difficult to measure (low P2) in an actual dairy system because there will always be some backpressure on the valve due to downstream equipment.

In cases where there is a dual mix/milk homogenizer with a grooved valve on the first stage, a piloted second-stage would be provided for better viscosity control. When operating on milk, there should only be enough pressure applied to the second-stage actuator to keep the valve from chattering against the actuator rod. In no case should the second-stage pressure exceed 100 psi.

The correct sequence for setting the two-stage valve is as follows. The second-stage valve is set first, followed by the first-stage valve, to give the total pressure desired. For example, for 2000 psi the second-stage would be set to read 200 psi, and then the first-stage valve would be set for the total pressure of 2000 psi. The actual pressure drop through the first-stage valve would be 1800 psi.

The reason for this sequence is that the two valves are not fixed valves, and the second-stage pressure can influence the forces acting on the first-stage valve. Therefore, if the first-stage valve were set first, followed by the second stage, then the forces acting on the first stage would change. This would cause a shift in the first stage pressure. The total pressure would still be the same, but there would be uncertainty as to how the total pressure was distributed between the two valves. If a pressure gauge were positioned between the two valves, then the first and second stage could be adjusted independently.

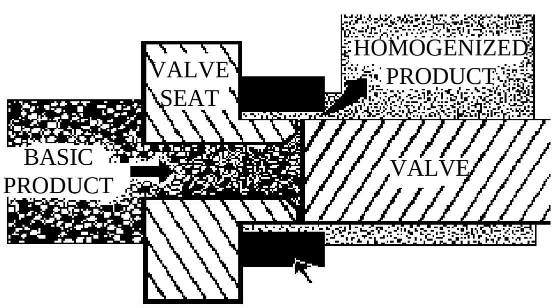

FIGURE 1
How the Homogenizing Valve works

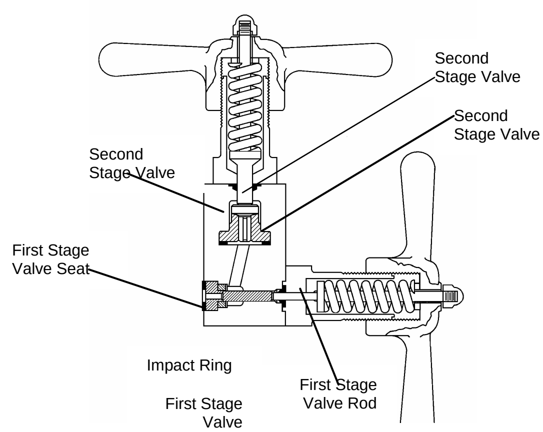

FIGURE 2
Two-Stage Homogenizing Valve Assembly

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FIGURE 3

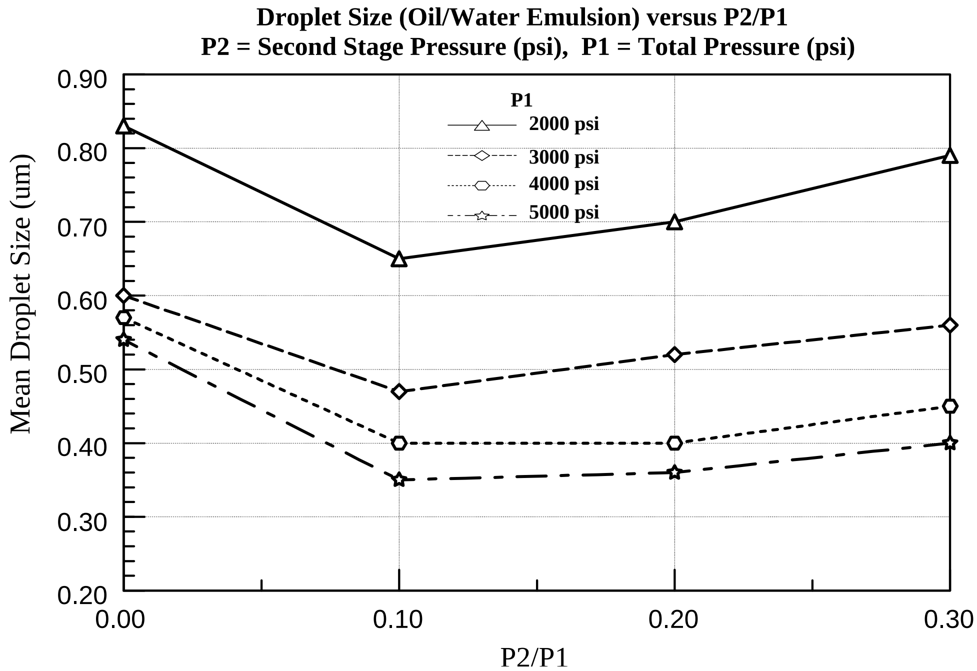

FIGURE 4

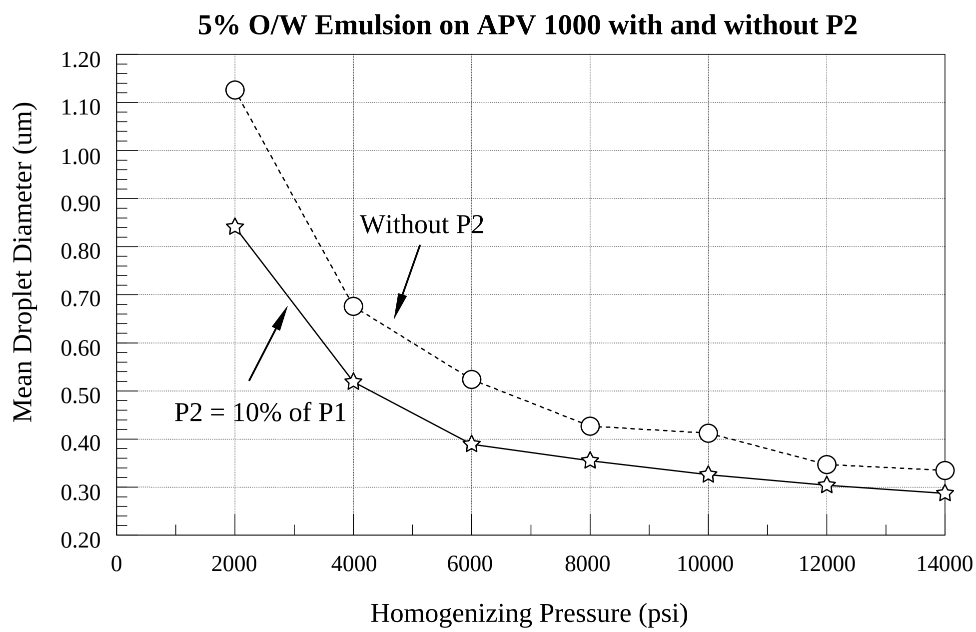

FIGURE 5