Run Times
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Pumps are often operated in parallel when a flow rate higher than what can be provided by a single pump is desirable. However, caution is the watchword for parallel pumping. There is a serious risk of equipment problems unless an operator understands fully the performance each pump.

Dale B. Andrews
Dale B. Andrews – Editor

Six truths about parallel pump operation

1. For any given discharge head[1]-[2], flows for parallel pumps are additive
2. The system flow rate will be determined by the intersection of the system-head curve and the performance curve of the parallel pumps
3. Pumps of different hydraulic characteristics may be operated in parallel to the extent that they share common discharge head characteristics
4. Pumps of different hydraulic characteristics may encounter severe problems when operated in parallel
5. All pumps have different hydraulic characteristics
6. To produce flow, a pump must generate a greater discharge pressure at start-up than the pressure already present in the system

[1] Total Dynamic Head (TDH) is not necessarily a true indicator of parallel pumping compatibility. It is the discharge head that is determinative as to whether parallel flow will occur when two or more pumps attempt to discharge into a common header. TDH is the net difference between suction and discharge head. Two pumps operated in parallel with identical TDH would not have the same discharge head if their suction conditions were different (for example: one pump with an impaired suction).

[2] This discussion assumes that the same fluid is handled by each pump. For fluids of different densities, pressure must be used and not head.

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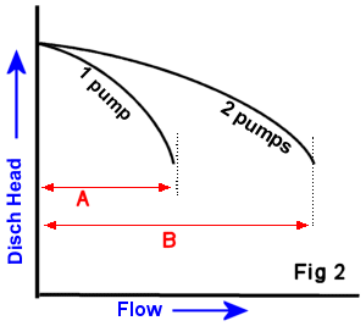
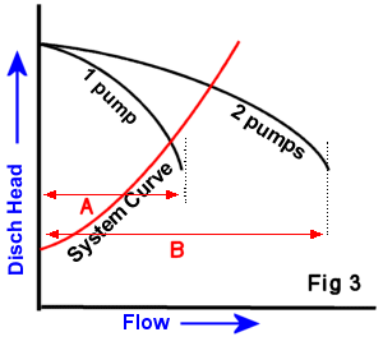


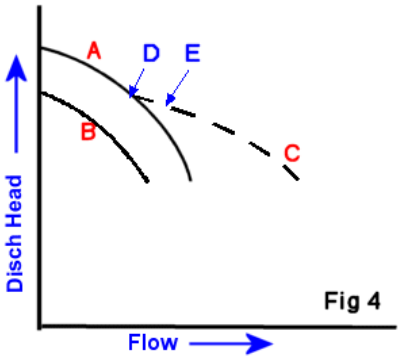
Referring to figure 2: at any given discharge head flow B will equal the sum of the flow from each pump A. Furthermore, the power draw of each pump will be the power draw at the contributing flow rate for each pump. It is generally desirable to use just one pump where one pump can do the job. Multiple small pumps will have a higher capital installation cost and will combine to draw more energy than a single properly designed larger pump. However, some other factors, such as limited Net Positive Suction Head Available (NPSHA), may preclude the use of a single pump.

The system flow rate will be determined by the intersection of the system-head curve and the performance curve of the parallel pumps

Although the flow capability is additive for parallel pumps at any given discharge head, the actual output of the pumps will be determined by the intersection of the system-head curve with the parallel performance curve. For a system where the system curve is dominated by frictional losses, parallel operation will generally mean a lower flow than twice the single pump flow (Fig 3). When the discharge head is variable, such as with a control valve, then flow will be controllable when within the range of the valve.



Pumps of different hydraulic characteristics may be operated in parallel to the extent that they share common discharge head characteristics



So far the discussion has been limited to supposedly identical pumps (a scenario that we'll find out shortly does not exist other than on paper). However, it is possible to operate very different pumps in parallel provided that they share common discharge head characteristics in the region of parallel operation. Fig 4 depicts characteristics for two different pumps A & B. Following rule No. 1, that for any given discharge head, flows for parallel pumps are additive; the parallel operation curve consists of curve A to point D, and curve C. Point D corresponds to the shut-off head of pump B. Curve C represents the additive flows for A and B that share a common discharge head.

Pumps of different hydraulic characteristics may encounter severe problems when operated in parallel

Referring again to Fig. 4: point E corresponds to the minimum flow rate of pump B. As long as the system curve intersects the parallel operation curve between points E and the maximum allowable flow, everything is fine. If for any reason the system head curve should shift to the left of point E, pump B will be compromised either mechanically or thermally. If the system head curve should shift to the left of point D, pump A will start to run singly and pump B will operate at zero flow. As will be discussed further in rule 6 below, it is important to note that pump B can never come on line against pump A unless pump A is operating at a flow greater than that at point D.

The paramount question is whether the operator has the capability to know what the actual flow for each pump is. Operating pumps blindly in a configuration like that shown in figure 4 is very risky. Pumps wear; heat exchangers foul; and control valves open and close. A dead-headed[3] pump, especially a vertical dead-headed pump, can run amazingly smooth – right up until failure. To operate dissimilar pumps in parallel, one would need to make sure that pump B was equipped with a minimum flow recirculation line and preferably, flow monitoring instrumentation. It should also be noted that the pumps might be of the same size and model and yet be "dissimilar" simply because one is badly worn and the other is not.

All pumps have different hydraulic characteristics

Most pump hydraulic components are built from castings. Even when new, differences in casting surfaces, clearances, and tolerances usually result in slightly different performance curves. For well-made industrial pumps these differences are generally small, and given continuously rising curves and similar shut-off heads, parallel operation is not a problem. In contrast, for cheaply made products the performance differences can be substantial. One should also be cognizant of the fact that any stage variances within multistage pumps are cumulative across the number of stages.

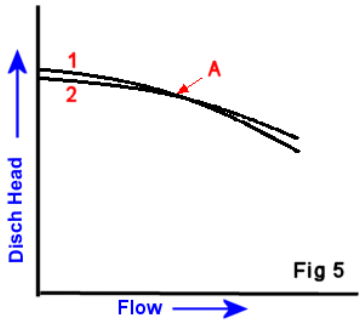
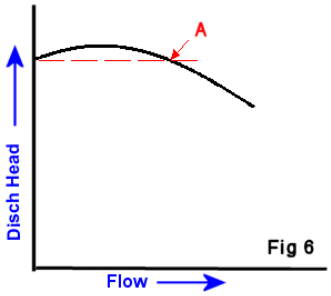


Fig 5

Curve shape is very much a factor in evaluating supposedly similar pumps for parallel operation. For example, the pumps shown in figure 5 have very similar discharge head characteristics, but in parallel operation they will have the same issues outlined above for the dissimilar pumps in figure 4.

[3] Zero-flow

A pump must generate a greater discharge pressure at start-up than the pressure already present in the system



Probably the most commonly discussed (but not necessarily the most prevalent) problem concerns supposedly identical pumps with a non-continuously rising head curve to shut-off (Fig 6). If the system curve intersects the pump curve anywhere to the left of point A, a second pump with similar characteristics cannot be brought on line. It can be seen from Fig 6 that any of the flow-rates to the left of point A, except for zero flow, have a head that is greater than the shut-off head of the second pump. Obviously, the same issue exists for dissimilar pumps such as in Figure 4. (Pump A of Figure 4 can always start against a running pump B, but pump B can only start against pump A if pump A is operating to the right of point D.)

In summary, parallel pump systems are more expensive, less efficient, and create problems with load sharing that single pumps do not. There are some valid reasons for parallel pump operation such as when switching over pumps, NPSHA considerations, and handling intermittent peak load situations that cannot readily be satisfied with a single pump. When faced with spending constraints, one might also be driven towards parallel pump operation to increase system throughput as an alternative to purchasing new pumps. Operating pumps in parallel is viable providing that it is done with a full understanding of the individual characteristics of the pumps involved and the ability to monitor or ensure minimum flow thresholds are met for each pump.