

Single Impeller Pump Designs vs Multiple Impeller Pump Designs

There are two basic reasons to use two impellers on fire pumps.

The first is to gain more pressure at a given impeller shaft speed (rpm), by having one impeller discharge feeding the second pumps intake. This is called operating in series. This design will allow you to either generate a higher pressure (400 to 600psi) or operate the pump at a lower speed. This series only design was popular in Europe when quality high speed ball bearings were hard to find (we had that same problem in North America 100 years ago). In the North American market, we used the series design for more pressure capabilities.

The second reason to use two impellers is to create a higher flow output using existing smaller impeller designs (parallel operation). The common two stage pumps we see on the market have a transfer valve and internal check valves to provide high flow or high pressures. The advantage is the generation of the higher pressure when in series and low flow efficiency at lower pressures. The big draw backs include lower HP efficiency at higher flows where HP efficiency is needed the most and check or transfer valve maintenance problems.

There have been a few parallel only high capacity pumps offered to the market. The first was the American Pump PV2, from the 70's this product was redesigned in the 80's and was called Double Thunder. It used two 1250 or 1500 impellers to achieve 2500 to 3000gpm pump ratings. Other companies have also followed this concept of two existing production impellers to create high capacity ratings (3000 to 6000gpm).

There are three drawbacks to this concept. First more parts to deal with, needing maintenance and more to fail. The second is you need to match the flow into both impellers, and even any minor variation in impeller performance or input flow will cause lower flow performance and require higher HP efficiency.

The third issue is over all HP efficiency. The bigger the impeller is the easier it is to get better HP efficiency. Your typical 3000 gpm impeller is 67 to 74% efficient, whereas a 5500 to 6500 gpm impeller is 84% to 87% efficient. The current 600HP engine offered in current Fire Apparatus which are available to our market can only supply about 525HP to the pump after fan and alternator parasitic loses. This leads to a big single impeller generating a rating of 6250 gpm at 125psi (87% efficient) verses a twin impeller pump generating 6000 gpm at 100psi (67% efficient). When operating from draft, 100 psi is not sufficient to feed a monitor at maximum output. 115 psi at the monitor base is required and you will still need a more pressure to overcome hose and plumbing loses. So, with the double impeller design you will be down to an estimated 5000 to 5600 gpm.

The question is why make a twin impeller capacity only pump? There is only one reason you want to use existing smaller impellers. To save money and development time.

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