THE PUMP GUY

"ANOTHER LEAP OVER THE PRECIPICE OF PRUDENCE"

There's a war going on. No, I'm not talking about that war. I'm talking about the war being fought between mechanical seals, and seal-less pumps. There are about three magazines dedicated solely to pumps, and the pumping and process industries. And, there are another three or four magazines with monthly feature sections on pumps. And then, there's me, the PUMP GUY. You have all seen these magazines, the articles, and the ads. Have you noticed how the ads have changed in the last two years?

There was a time when the pump companies would tout their 'complete line' of product. "Buy all your pumps from us because we make submersible pumps, chemical pumps, positive displacement pumps, centrifugal pumps, high-temp pumps, multistage pumps, etc." Other ads would talk about complying with ANSI, or API, or ISO standards. Still other ads would brag about features like non-clog impellers, back pull out designs, self-priming, low NPSH (go to your CHEAT SHEETS), and exotic metallurgy. Now, there's only one design being promoted...the seal-less pump. The ads say that their pump has 'no unreliable seals to fail mysteriously'. Still other ads say buy our seal-less pumps and 'get rid of leaks from dripping mechanical seals'. When you read one of those hero stories in the magazines written by the sales manager of the pump company, the article talks about 'zero leakage', 'zero emissions and 'double containment'. Then the article goes on to talk about what to do in the unlikely event of 'breach of containment'. Breach of containment? Sounds like verbal flatulence for leak!!!

There also was a time when the seal companies would tout their complete line of product. The ads would say, "Buy from us because we make both pump packing and mechanical seals." Other ads would say, "Convert your packed pumps to our seals with no pump modifications". Other ads talked about seals complying with ANSI, API, and ISO standards. And there were the seal ads promoting features like, balance, cartridge, slurry, high temp, split, dry gas, and inflatable designs, you name it. (This is like the previous paragraph isn't it?) The mechanical seal ads have evolved into..."zero emissions seals", "environmental seals". Mechanical seals no longer seal pumps. Nowadays, they "run more efficiently than seal-less pumps." Today, pumps with mechanical seals "use smaller motors and cost less to repair than seal-less pumps." I know this because I read the hero stories written by the sales manager at the seal company. DUH!!!

Numerous times each week, through the internet and e-mail, I'm in communication with mechanical seal salesmen who are jumping up and down, wringing their hands and loosing customers and applications to seal-less pumps. Their customers are no longer content with mysterious failures and short seal life. An engineer at a food processing plant told me the other day that he was so 'fed-up' with unreliable mechanical seal life that he's going to scrap all the electrical conduit in the plant, install compressors and accumulators, and string pneumatic lines throughout the plant to power his AODD pumps. This might have you believing that the seal-less pumps are winning the war.

On the other side, I have a friend who used to be a maintenance engineer in a

pharmaceutical chemical plant. Six years ago he converted his plant from mechanical seals to seal-less canned motor pumps. Two years ago they kicked out the seal-less pumps and went back to mechanical seals. My friend turned in his walkie-talkie, beeper, pager, cell phone and the 24/7 life of a maintenance engineer and now teaches vibration monitoring. Another engineer in a different plant bought five mag-drive pumps about five years ago. Last year he had cannibalized four pumps to keep the last one running and gone back to conventional seals on the other four pumps.

In the Pump War, industry must decide between the pump with a mechanical seal, and the seal-less pump. Battles will be won and lost, and there will be casualties. The Pump Guy, once again will step over the precipice of prudence, and say, "Victory tends to Favor the Prepared Mind."

The prepared mind understands that the system governs the pump. This is in your CHEAT SHEETS. As to whether seals, or seal-less pumps are better in a particular application, is a matter of understanding the nature of the system. Let's consider some situations and see if we can't arrive at a truce.

To come up to speed, we'll bring up some random information from your CHEAT SHEETS in previous articles and build on the information. This is somewhat technical so pay attention. :
* The system governs the pump.
* The pump runs at the intersection of the pump curve and the system curve.
* The pump should run at, or close to its best efficiency point, the BEP.
* The BEP is usually somewhere between 80% and 90% of the shut-off head.
* The shut-off head is a point on the pump curve representing maximum head at 0-gpm.
* The total head of the system, TDH = Hs + Hp + Hf + Hv, where Hs is the elevation change across the system, Hp is the pressure change across the system, Hf is the energy lost to friction in the piping and fittings, and Hv is the energy spent due to the velocity of the fluid moving through the pipes. If this energy is going to be lost into the piping, then it must be built into the design of the pump

The graphic below represents a basic pump curve showing: shut off head, BEP, with the corresponding best efficiency head in feet, and best efficiency flow in gpm.

FIGURE # 1

BASIC PUMP CURVE
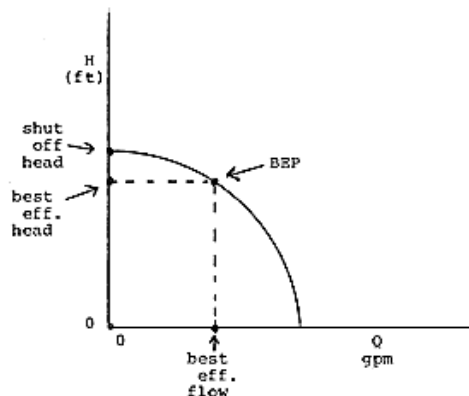
TDH ≈ BEP. Add this to your CHEAT SHEETS. The pump runs at the intersection of the pump curve and the system curve. The goal of every design engineer is to design the pump so that the TDH ≈ BEP. It is the mission of every purchasing agent to buy a pump who's BEP ≈ TDH. Every Process engineer and operator is charged with keeping the TDH ≈ BEP. If the TDH ≠ BEP, then the mechanic's mission will be to change seals and bearings on the conventional sealed pumps, or to rebuild and repair the seal-less pumps. Now let's consider the system curve.

The system curve is the graphic representation, or picture of the TDH. We begin with the basic H-Q graph of the standard pump curve, and we will plot the TDH. Notice that the TDH has four elements. Two of the elements, the Hs and the Hp, exist before we turn-on the pump. We know before we turn on the pump, that we've got to complete the requirements of the elevation change, and the pressure change across the system. Therefore, these two elements will be plotted at 0gpm and go up the vertical (H) axis. The static head (Hs) is plotted as a 'T', and the pressure head (Hp) is plotted as a circle or vertical oval stacked on top of the Hs. Observe the graphic.

FIGURE # 2

SYSTEM CURVE WITH Hs & Hp
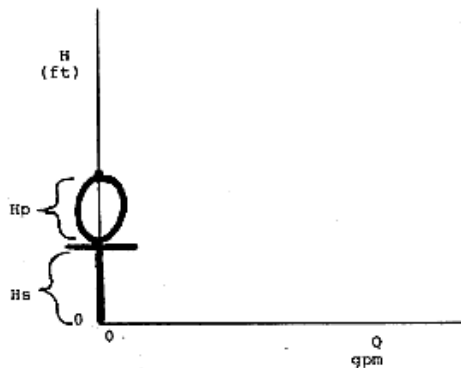
The other two elements of the TDH, the Hf, and Hv, only come into play after we turn on the pump. There is no Hf or Hv if there is no movement in the pipes. Hf and Hv will begin at 0-gpm and go up as flow goes up. How? Well, the Hf and Hv can be measured with gauges on an existing system. Or they can be calculated or approximated with some formulas when designing a new system that does not yet exist. Consider the following:

From the Affinity Laws (previous CHEAT SHEETS), we learned that the change in flow is proportional to the change in speed of a pump. Mathematically: 2x speed = 2x flow, and ? x speed = ? x flow. And, we learned that the head changes by the square of the change in speed. Mathematically: 2x speed = 4 (2^2) x flow. Then, if flow changes proportionally to the speed, and if head changes by the square of the change in speed, then head changes by the square of the change in flow. Right? Huh? Believe me!! I did say that it was going to get technical.

We would use a variation of the Affinity Laws to calculate how the Hf and Hv change with the change in the flow. Mathematically: Hf & Hv α Q^2, or the friction and velocity

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head will increase by the square of the change in flow. The curve would be a logarithmic curve and it would begin at the top of the plotted Hp (or Hs if there is no Hp) and it would increase as flow goes up. It would be plotted on the graph like this:

FIGURE # 3

SYSTEM CURVE SHOWING Hf & Hv STACKED ONTO Hs & Hp
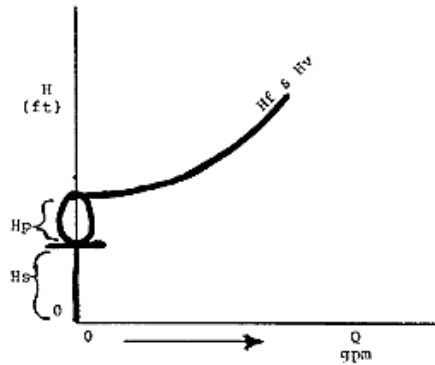
Actually, two smart guys named Hazen and Williams developed a second variation on the Affinity Laws. They took the basic formula and introduced about a 15% error or correction factor into the Affinity Laws here, because they did some studies and learned that not all pipe is new, or true. Therefore, the Hazen and Williams formula states: Hf & Hv α $Q^{1.85}$. Some design engineers use the basic Affinity Laws, and others use the Hazen and William's formula.

It's something like a blind man hitting the bull's eye with an invisible dart. Remember that these calculations are approximations of friction losses when designing a new system that doesn't yet exist. If the system already exists and you are charged with finding the problem in the pump, then go install some gauges on the system and take your differential psi readings with the system turned off, and then with the system running. The difference between the two sets of differential readings can only be the Hf and Hv in the system. This is somewhat complicated for this article. We cover this thoroughly in my lecture series. You'll leave the lecture prepared to stop changing seals and bearings.

When we plot the system curve with the pump curve, we have the following picture:

FIGURE # 4

SYSTEM AND PUMP CURVES
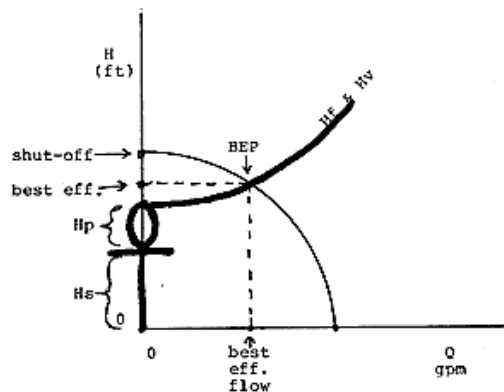
This is where the pump always operates...at the intersection of the pump curve and the system curve. You can see how the pump is affected on its curve if the friction losses should change, or if the elevation or pressure should change in the system. The pump moves away from its BEP, and maintenance goes up. It doesn't really matter if the pump has a conventional mechanical seal, or if the pump is a seal-less pump. The goal of the design engineer is to be sure that this point of intersection is at or near the pump's best efficiency point. This is why we say the TDH = BEP.

Let's now consider two pumps running in parallel, and see how the door opens to mysterious failure. To begin, what is parallel pumping?

Parallel pumping is two or more pumps running side by side in a common system. Think of two mules (I'm from Alabama) side by side pulling a wagon. (If you're from California, imagine two straps holding you down while you get your tongue pierced.) Parallel pumping is when the system is designed for both (or all) pumps running together, but occasionally only one pump runs (or some pumps run) in the system.

Parallel pumping is not a side-by-side "A/B" alternating system. This is a system designed for only one pump, where pump A is run for a period of time and then alternated with pump B running for an equal period of time. An alternating "A/B" system is designed for either pump A, or B, but not A & B running together. The piping arrangement looks similar, but it is not the same. The biggest physical difference would be either a directional valve in the suction piping (to pump A or pump B), or shut-off valves in the suction piping of pump A and pump B. These would not be necessary in a parallel system. And parallel pumping is different from series pumping in that series pumping is where the discharge of one pump feeds the suction of the next pump.

Examples of parallel pumps would be pump banks, where the suction piping of more than one pump is drawing off a common manifold, and with the pumps discharging onto a common header or collecting pipe. These are seen at cooling towers, hydronic loops, chill water loops, and other circulating systems. Maybe all pumps would run during the day or at high production, and only some pumps would run at night or during low production. . The parallel pump and system curves appear like this:

FIGURE # 5

PARALLEL PUMPS WITH THE SYSTEM CURVE
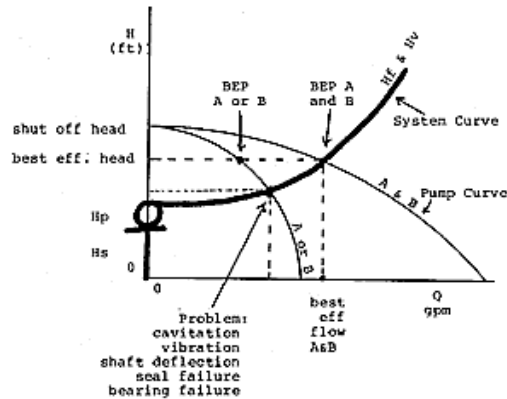
As the graph shows, pumps A and B, running together in parallel, will be running at their best efficiency point when mated into a system designed for parallel pumping. A problem appears when running only one pump though. Operating either Pump A or B independently, will cause the pump to run to the right of it's best efficiency point and this pump will be operating in the cavitation zone and will be problematic and a maintenance headache.

If you are using seal-less pumps in this application (or if you sold seal-less pumps into this type application), THIS is the reason that too many seal-less pumps are considered to be problematic. THIS is the reason that seal-less pumps spend too much time in the shop, get a bad reputation, and your conversion project becomes a reversion back toward conventionally sealed pumps. You do not have free reigns to trade-out your conventional mechanical sealed pumps for seal-less pumps unless you're also going to install a complete set of gauges, sensors, transmitters, and programmable logic to keep your system changes adjusted to the BEP of your pump. Or did you think your pumps could survive cavitation? Where does the literature say to install seal-less pumps into obviously cavitating systems?

For the mechanical seal salesmen and seal companies, The Pump Guy says SHAME ON YOU. Shame on you for not doing anything about mysterious seal failure!! Shame on you for thinking that good service is delivering another seal that will fail for the same reason four months later. Can you imagine the level of frustration your customers feel as they buy larger motors, or compressors and accumulators to power their seal-less pumps? They really want you out of the plant. After your customer converts to seal-less pumps, how many seals do you expect to sell to that customer now? And even if he does come back to seals, do you think he's going to use your seal again? The Pump Guy said in a previous article that the mechanical seal industry brought about the invention of the seal-less pump? If you want to blame someone, go look into the mirror!!

Now, I wouldn't be the Pump Guy if I didn't offer a solution to the problem that exists in parallel pumps. The solution is right under your nose. Stop selling single seals into parallel pump arrangements. Mathematically: single seal/parallel pumps = another mysterious seal failure. Go with a Double Seal. Install Double Seals onto pumps in parallel service. Double seals, piped properly, can handle cavitation. Single seals

cannot.

The reason you never hit onto this before is because you've never read seal literature promoting Double Seals on parallel pumps. If you read your seal literature, it says Double Seals are for dangerous, hazardous, toxic, explosive, and volatile liquids. There's no seal literature calling for Double Seals in cold-water service. Cold water is generally thought to be an application for single seals, right?

Cold water is what you find in a chill water loop or a cooling tower. It's considered to be an easy application. You expect the mechanical seal to be problematic in a hot acid slurry pump. Who would have thought that cold water is an application for a Double Seal? That's why it is so frustrating when the seal on a cold-water pump is problematic. If you don't get onto Double Seals in this application, you're going to lose your customer to seal-less pumps. As for your barrier tank arrangement: vented tank, not sealed, forced flow, not induced flow (no pumping rings) and don't depend on thermal convection. I know you're wondering, "What piping arrangement or API Plan is this?" Actually it's not recognized. Call it API Plan # 69. Don't worry that it's not recognized. You have to deal with cavitation, not some 'recommendation committee' members. What did the 'committees' ever do or recommend for surviving cavitation? Where's that provision? DUH!!!

The Pump Guy said in a previous article that pump companies generally don't understand seals, and seal companies generally don't understand pumps. This is why your seal supplier never published literature recommending a Double Seal in parallel pumps. Watch closely. The Pump Guy predicts that some of the recently formed mega-glomerates are going to come apart before the year is out...because they don't talk to, or understand each other.