Variable Frequency Drives and Energy Savings

By Randy Hellbusch, Circuit Rider

I haven't had any specific hands-on experience with Variable Frequency Drives, but it is something that interests me. I feel it can be one of the greatest operational tools to come along for water systems in a long time. At our annual national in-service this June I had the opportunity to listen to John Regnier, with our national office, give an informational talk on how utilities can save money on energy costs. The installation of a VFD could help your utility to accomplish that. The following is an article written by John Regnier on how VFDs may be able to help your system.

Ergs, Joules & Such
Notes on the Energy Savings for the Rural Water Community and Maybe Others
By John E. Regnier, NRWA

Curious about Variable Frequency Drives? Read on

So far in the brief history of this newsletter we've concentrated on those practices that normally don't involve capital expenditures. I'm going to break with that history and spend at least this issue talking about variable frequency drives (VFDs). All of you have probably heard the term and may have considerable experience with these devices that have so much potential to reduce energy consumption and improve system operations. What I'll be reporting to you I've gleaned through a modest research effort into the subject and not from personal knowledge - I regret that I have absolutely no personal experience with VFDs. I would welcome comments and suggestions from you readers who have first hand knowledge about this important subject.

- First, we need to go back to school briefly if this discussion is to make sense. Definitions first: VFDs are devices that change the speed of electric motors by changing the frequency of the electric current supplying the motor. Other names you'll hear bandied about are Variable Speed Drives (VSDs) and Adjustable Speed Drives (ASDs). These names are not necessarily interchangeable but refer to the process of controlling motor speed by mechanical or electronic means. In this issue we'll talk just about VFDs.

- A word about frequency - this refers to the property of alternating electric current of changing polarity from positive to negative in cycles. The number of these cycles that occur per second is the frequency - one cycle per second is one Hertz (Hz) and most AC current has a frequency of 60 HZ.

- Turns out there are some clever ways an incoming current of 60 Hz frequency can be changed, especially lowered for our purposes, without affecting the other characteristics of the current too drastically. The way this is done is probably not critical for our needs, but what is important is that **lowering frequency some percent lowers motor speed the same percent**.
- Why is all this important? For several reasons, but from an energy standpoint, the chief one is that the horsepower of a centrifugal pump varies as the **<u>cube of the speed</u>**. What that means in practical terms is that if you have a 100 hp pump currently requiring 80 kW to operate and you cut the speed to 50%, the horsepower is reduced to (0.5)3 or 12.5%. **<u>Thus the kW required is potentially reduced to 10 kW</u>**. Unfortunately, because of some losses in the frequency reduction process, the real savings aren't quite that good, but still substantial.

- What's the downside? The only one I can find is cost. Haven't been able to get too much cost info, but it looks like the installed cost may bounce around $100/horsepower. That's sure significant, but not impossible.

- Let me leave you with this thought …. If you don't pay your electric bill, will you be delighted???? …….. Till next month

More About Variable Frequency Drives

In the last issue we introduced the subject of variable frequency drives (VFDs) and covered some basics about these versatile devices. I have continued to review material on this subject and think a few additional things are worth sharing. First though, remember that from an energy standpoint, if you reduce the speed of a pump, the **horsepower may reduce by as much as the cube of the speed**. The potential energy savings are large.

- Fortunately, energy savings are not the only benefits VFDs offer. A key additional advantage is their ability to soft start motors with resultant energy savings and reduction of water hammer. The main downside to this application is cost. VFDs are significantly more expensive than traditional soft starters.

- A principal consideration in making a choice between VFD motor starting and traditional soft start devices is whether your load varies. With traditional soft starters, once the motor reaches full load speed it remains at that speed, whereas, with VFDs the speed can be varied with load or demand.

- Are there downsides to VFDs other than cost? Sure – one of the principal ones is that they can introduce undesirable harmonics into the electric circuit of an installation. However, this can be corrected and ultimately is reflected in the cost of the VFD.

- If you'd like to know if your system would benefit from VFDs, what are some of the things you should consider? Here are a few and if you answer yes to any, you probably need to at least investigate VFDs: (not an exhaustive list)

  1. Are your pumps and motors over sized? For example, do you have pumps that operate for relatively short times to meet water demand?
  2. Does your water demand vary significantly over time?
  3. Are you having power factor problems?
  4. Do you have air handling situations where volume requirements vary?

- Want more information? Here are the links to a couple of web sites I found particularly helpful:
  1. http://www.joliettech.com/
  2. http://www.pacontrol.com

- You might want to do some thinking "out of the box" and see if you come up with some unique applications for your system. The ability of these devices to match output to demand offers some intriguing possibilities. What about meeting fluctuating water demand this way rather than with an expensive tank??

- Finally, talk about energy cost………"Guy's wife wanted to go somewhere expensive for their anniversary so he took her to a Texaco Station"……. Oh well -----

Concerned or curious about Power Factors? Read on

Although most of these newsletters are devoted to energy saving suggestions that cost little or nothing to implement, for the last two issues we've been talking about variable frequency drives (VFDs) which do cost serious bucks but can have serious benefits. Another area somewhat in the same category is power factor correction. Although most of the systems I work with don't get involved with power factors, I seem to be encountering it more frequently and thought we ought to spend an issue or two on it although it's a bit difficult to understand.

- First of all, how do you know if you need to be concerned with power factors? Easy – just look on your power bill. On the part of the bill that details how the bill amount is calculated you are likely to see a line that says power factor or power factor correction followed by an amount. If it's not there or the amount is zero, then don't worry about it. You aren't being penalized for low power factor. However, if there is an amount on the power factor line, you probably are being penalized and you'll want to pay attention to the following:

- So, what is it? Well, basically it's a reflection or measure of how well your motors are designed electrically. Power suppliers generally try to discourage poor design by price penalties because if the power factor is seriously low, the supplier has to supply more current to get a job done than it should have to.

- Technically, power factors are a measure of how much current lags (or leads) voltage changes in an alternating current system. If you aren't electrically trained or inclined, that probably sounds like so much Greek, but maybe the following illustration will help some of you a bit.

- Try to think of electrical power as having a direction (toward the customer for example). If things were ideal, all the power supplied would be in a straight direction away from the supplier as represented by the horizontal line labeled "Real Power" in the illustration. However, with induction loads (motors) forces are generated that try to push the current back toward the supplier and the horizontal line gets raised to a slant – "Apparent Power" in the drawing. The height of this slant – "kvar" in the drawing – is a measure of the effect and the power factor is the ratio of Real Power to Apparent Power.

Power Factor=Real Power/Apparent Power