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February 23, 2015

An Engineers Five Step Plan to a Successful New Line Start Up

Many new lines are built and commissioned every year and the large majority of they come online producing in specification product in a short period of time, if not at the initial start. There are however, lines where nothing seems right or to go well at the point where production is required. The question(s) that is raised at that point are;

1. Why is this happening?
2. Whose fault is it?
3. What doe we do to correct the problem?
4. Who pays for the changes?

As you can imagine, this is not a happy time to be associated with the line but with a little extra attention it could have been a resounding success.

So what is the genesis of the few times when a line starts poorly? In my experience it is usually related to the lack of a clear description of what the line is supposed to do, or a poor specification. What do I mean? First you will generally get what you ask for, and if you ask for a film line, you will get a film line. But, if what you really wanted was a line to produce a barrier coextrusion for deep draw thermoforming, you may end up with a line for cast PE or cast PP for bread bags! It is all in how you ask (side bar A: creating a new line specification; asking for what you want).

Assuming you have specified the line well, how can I make sure the line starts to produce sellable goods in the minimum time? There are five start-up steps every business owner, manager, project manager and process engineer should know when installing and starting a new line. These Five steps should be performed in sequence and not all at once during the line start in production.

1. First the “Smoke test”, (turn it on and make sure it keeps working)
2. Second, all critical process safety or shutdown switches and indicators are operational. Any item which can cause a run away must be checked carefully,
3. Third, all of the moving parts of the line must be checked to insure they turn the right direction, don’t shake themselves to pieces or suffer from excessive wear at start up.
4. Fourth, confirm the design calculations of each critical process component ***by measuring the actual performance*** with the materials you plan to use
5. Fifth, start the line and begin the process of making the product to specification. Once

again measuring the performance against targets.

These five steps can be done in sequence as each component is installed, prior to shipping to your location and in combination with other installed components. For me, one of the most critical steps is step four, as it determines if the line will be able to produce product at the rate and quality that you need for maximum productivity and profit.

Five steps, almost sounds almost too simple, but it is very necessary to insure that all is well when product production is scheduled and new capacity is needed. A poor line start up is in no ones benefit, except perhaps your competitors.

Who is responsible for all of these checks? Ultimately the purchaser, but how and who conducts the checks, pays for necessary modifications etc. are a partnership with the supplier (if a turn key) or critical component suppliers. At times there may be multiple entities responsible for the final outcome. This has to be clear in the contract for the supply and installation of the line and various technology components. If it isn't clear who is responsible for a poor start (it could be you!), then you can only hope for honest suppliers who stand behind their equipment, or perhaps the courts. Make sure they did not supply a terrific line for the production of a product you did not really want.

So let's look at the purpose and conduct of each of the five steps.

The "Smoke Test" is the first step and its purpose is to find wiring or installation errors and to find components which are "weak", of poor quality, broken or which are destined to fail early. This is important for electronic systems where components either fail early or at very long times. Nothing is more frustrating or costly than waiting two weeks for a replacement board which had a resistor burn up while the full production staff is in place ready.

Next, after everything is assembled check all the emergency shut down systems and e-stop circuits before putting the line into operation. This means all of them and requires a disciplined and deliberate approach. These systems are to protect the operators and the equipment from harm, and as such there can be no compromise in its conduct.

Try and start the line with each safety circuit activated (should not start) and power down the line by activating each one. Nothing is more terrifying than punching an e-stop and haveing nothing happen, or more frustrating than to have one activate when it wants.

Now we are ready to "start the engines". Lubricate everything and check oil levels etc. Check that everything that should turns (and that they don't turn if they should not), that they turn in the right direction, the lubrication is working, they don't make noises, don't run at high power and don't shake. I think you can get the picture. Take initial vibration signatures if you plan to a monitor vibration or initial torque and power readings without a load. This is a good time to check roll alignment, bearings, look for bent shafts etc. To run an extruder with the screw installed, uncoupled the drive or better don't install screw yet so the gear box can be checked. Check all motor speeds and readout accuracy and calibrate all tension measuring systems.

Now begin to check the performance of the parts, and systems checking the design of the line components to determine if output will meet our expectations. Determine what needs to be replaced, redesigned or if all parts were designed properly. To me this is the most important step. The preceding steps make this step possible and the next step depends on the successful completion of this step.

In film process lines the key functions to check are the extrusion system, quenching systems, web transport and winding. The extruders supply the melt for film formation, the quenching system cools the molten combination to create the film at a given line speed, next the web transport system carries the film to the winders where it is collected in rolls for future use. There are other systems such as edge pinning and trim and trim removal systems to check but they complement and don't restrict performance (not always true!). They have to be checked against the performance expectations.

So how do we check an extrusion system for design rate compliance? First inspect and measure the screw profile, compare it to the screw design to make sure it was manufactured properly (It's your screw; you can and should have a drawing of it from the supplier). Measure the output, melt temperature and stability, motor power and pressure stability as a function of screw speed for at least one set of barrel temperatures. Output should be linear with screw speed. An output curve with a decreasing slope vs. screw speed indicates a screw that should be replaced

Quenching capacity and/or heat transfer coefficients can be measured several ways during film manufacture or directly. Points of interest will be water flow rate, water temperature rise across the roll and final film temperature. Film properties will be dependent on the thermal history of the polymer, so if we are adding capacity with the new line we will have to measure the thermal history of the new line and compare to the first line to get the same product performance.

Web handling and winding performance are a little harder to measure but the transport of film without wrinkles and creases or film stretching are key items. For winding there will be a film formulation component which cannot be ignored, but overall for winding I prefer the use of roll density (kgms/m^3) but the real proof of the winding process is slitting yield.

Having performed all of the checks of the line components it is now time to put the line into production. Focus on getting the line up to speed and begin adjusting settings to optimize film properties and quality. The first stage of the start up will be to get the film gauge flat by setting the average die gap and edge pinning systems to obtain a stable edge profiles and film formation while adjusting the die. For coextrusion systems adjust extruder temperatures to control melt viscosity to eliminate any melt disturbance which might be present. Knowing melt temperature as a function of output rate will be critical to maintaining acceptable coextrusion stability.

With film on the winder, the performance of the line can be fine tuned and film properties optimized. If the film is not on the winder it is not possible to fine tune the film properties. Optimizing film properties may take the form of additive concentration changes for surface properties or refinements of barrier layer thicknesses for barrier properties. Mechanical properties will be primarily controlled by polymer selection and on extrusion conditions and casting conditions.

Overall, if we concentrate on the first four steps, the last step should be easy. The real goal of the first four steps is to permit the routine formation of film and having it on the winder so that the properties can be refined. In the few cases where a new line start up does not go well, it is generally the case that one or more of the first four steps were not done or worse that there was no clear conception of what the line was supposed to do and the line has not been designed to optimize the production of the desired product.