By Andreas Anzel and Gernot Plevnik

shortening the curve

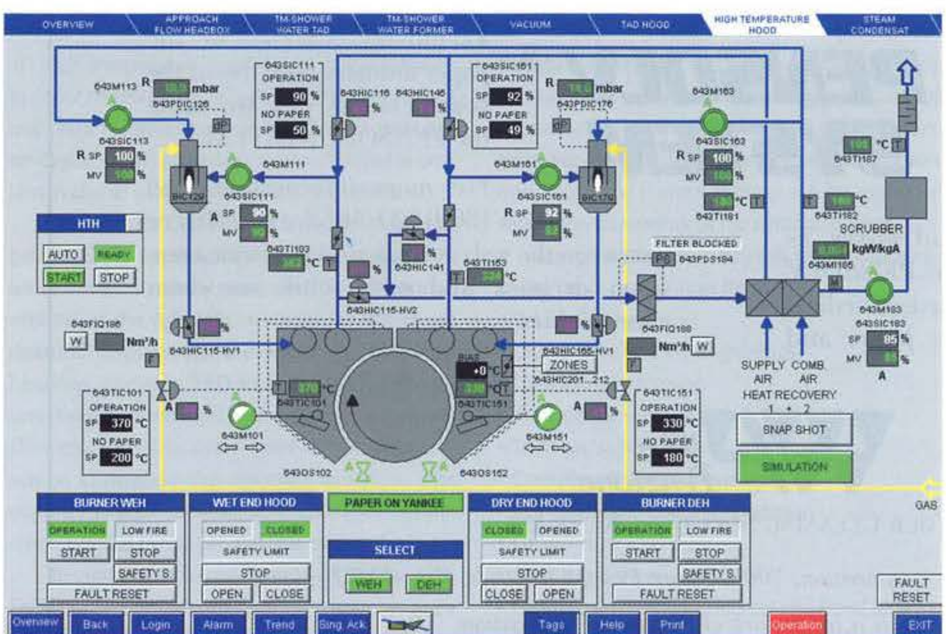
How dynamic process simulation can improve operator training for startups

Starting up a new tissue plant can be a big challenge. While equipment suppliers manage startups as a day-to-day activity, for many mills, a startup is a once-in-a-lifetime occurrence. Properly preparing and training operators prior to the actual startup shortens the startup curve and helps the mill ramp up to design production quickly and efficiently. Dynamic simulation is proving to be an effective tool for improving the efficiency of operator training, accelerating the startup and enhancing smooth plant operation.

Conventional operator training usually consists of classroom lectures, static slides, videos, animations, and perhaps visits to other mills with similar equipment. This kind of teaching is rather "one-way" – from instructor to student. Ideally, operators receive training at a similar plant, but even then, the operator often does not get the opportunity to train on all the potential process scenarios, startup and shutdown sequences, as usually the operation of a running machine must not be disturbed. Consequently, even this training is very limited.

With a dynamic simulator, these limitations are eliminated. The simulator is a combination of hardware and software, usually a distributed control system (DCS) with special process simulation software. Provided the simulator represents the plant in a realistic way, trainee operators can try out various scenarios without risking a loss of production or affecting plant safety. Through this personal "hands-on" training, operators become familiar with the automation system, the process, machine sequencing, and handling process disturbances in a safe manner. In short, the simulator helps them make better decisions, more quickly.

More importantly, this simulator training can be conducted according to a convenient schedule since it is available 24 hours a day. The simulator can be prepared well in advance of the actual equipment startup so that operators are fully trained to take over from the very first moment the machinery is started.



Screen of the "virtual" high-temperature hood showing the same features as the HTH display of a "real" operator workstation

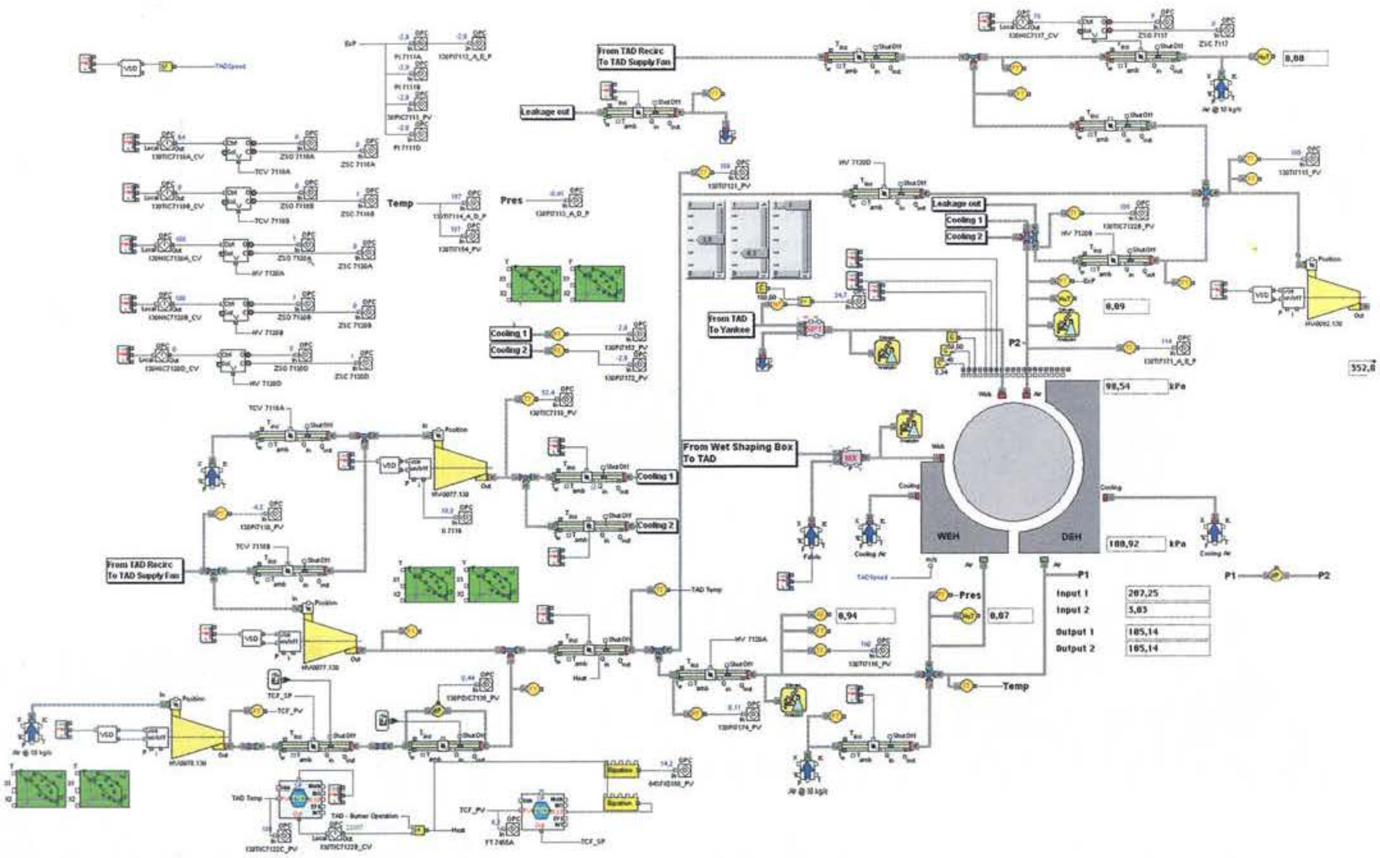
SIMULATING A REAL PLANT

In a real plant, the operator can control almost every process dircetly from his/her workstation. The operator input is directed to the DCS. There the data is checked for logic with respect to the control strategy and interpreted to derive new setpoints for the process machinery. The production process responds to these new setpoints, and the response can be seen on the operator's workstation.

The idea behind dynamic simulation is to emulate the behavior of a real plant using mathematical models. Any input by the operator is passed to that model via the DCS. The better the model, the more realistic the response of the "simulated plant." Ideally, the operator sees no difference between operating a real or simulated plant.

Building the mathematical model that represents the real plant is similar to building a plant in reality. Every single component must be set up and optimized. All plant components ("objects" in simulation language) are arranged on a worksheet and "connected" (the equivalent of piping).

Andritz uses a software package called IDEAS Gold. In this software, typical components, such as pumps, valves, pulpers, headboxes, and other equipment are available as graphic objects. The simulated plant is built electronically just like a real plant, including each pipe, pump, valve, controller, etc. The software also provides the tools to dynamically solve the mass, energy, and momentum (i.e. pressure) balances around the various components. Consequently, important properties, such as



This IDEAS Simulator worksheet shows the single objects of the TAD drum and air system

temperature, pressure and consistency of every flow in the plant are calculated.

Based on this simulation software, key or proprietary components can be developed and optimized. For example, Andritz optimized the "virtual" high-temperature hood object in the software in order to reflect the experience from numerous real plant installations. It is developed a through-air-drying (TAD) module from scratch that is now also available as an object on the worksheet.

The Andritz TAD Plant Simulator covers the process from approach flow to the creping doctor in detail. It can be controlled via the various screens of the operator workstation. There are detailed displays for the approach flow and headbox, vacuum, TAD section, high-temperature hood, steam and condensate system, all showers, and the drive system. An overview screen completes the operator interface. The supplier is also developing a simulator for the conventional tissue production process.

To guarantee the real "hands-on" feeling, the DCS hardware, software, and programming are identical to the DCS system in a real plant. In the current Andritz Simulator, the Simatic S7-400 and PrimeControl automation system are used.

TRAINING THE OPERATORS

The scope of the TAD Plant Simulator covers the start-up of the plant, shutdown procedures, changing of operating conditions and transition from one paper grade to another. Specific training scenarios can be developed, taking into consideration various equipment or operational failures. And finally, the control strategy can be explained within the framework of the simulated plant.

An operator must carry out numerous steps to startup a production line:

- Set operating speed
- Check headbox slice openings
- Check fabric tension
- Turn on vacuum
- Turn on Yankee steam
- Complete Yankee warm-up
- Check Yankee coating operation
- Group start TAD fans
- Start the burner
- Group start the high-temperature hood fans
- Turn on the high-temperature hood burners
- Start approach flow
- Check steambox set point
- Check vacuum setpoints
- Load pick-up
- Load Yankee doctor
- Load pressure roll
- Turn on stock.

A plant simulator can be used to train an operator to perform all these functions, as well as equally complex shutdown procedures. The training can be in either auto mode – allowing group starts of related components – or completely in manual mode.

A simulator can also be used to train an operator to make a smooth and efficient transition from one paper grade to another. Trouble-free transitions that maximize production are, of course, the goal. It is also possible to simulate how dewatering of the web affects downstream machine adjustments (e.g. if the stock pump flow and, consequently, basis weight is changed). The operator can compare the effect of various decisions for restoring the initial end moisture, e.g. by changing vacuum levels, fan output, hood temperature setpoints or Yankee pressure.

Simulation is also useful for demonstrating papermaking basics such as how to set headbox consistency by changing the slice opening.

Alternatively, the operator can experience how the headbox is influenced if the wire speed or the jet-to-wire ratio is changed. A simulator can also be used to train operators how to maintain output when confronted with unusual events such as equipment failures. An example might be how to react if one burner in the high-temperature hood system is lost. In such a case, the sheet moisture will increase instantly, resulting in a sheet break. When this is simulated, the operator can be taught how to re-establish operating conditions for the production of an acceptable paper quality and to bring the web onto the reel again for winding up. These decisions can mean the difference between daily profit and loss in a mill.

Another advantage of a simulator is that it can be used to enable an operator to become familiar with a control strategy (the various interlocks and control sequences) prior to actually being responsible for a machine's production. Interlocks prevent operational failures from causing harm to the plant. For instance, there should be no "stock on" before the Yankee doctor and the pressure roll are loaded; the TAD burner can't be started before the TAD fabric speed exceeds a minimum limit; the fan pumps can't be turned on before the headbox screens are in operation. Operators can learn about these interlocks and be able to handle interlock warnings on their own.


Operator running the through-air drying section of the Andritz TAD Plant Simulator

In addition to loop and control strategy verification, which was the role of dynamic simulators in the past, the latest simulation tools can train operators to run a TAD line in "virtual mode" well in advance of running the real plant. Operators learn in a "safe" mode, without any risk to the real machinery or to other people. They can try "what-if" sequences and see the results of their decisions. The benefits are well-trained operators who are ready to run a production plant efficiently. TW

Andreas Anzel is with the Tissue Machine Product Management and Technology group and Gernot Plevnik with the Automation Department of Andritz AG, Graz Austria. They can be reached at: andreas.anzel@andritz.com; and: gernot.plevnik@andritz.com