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PRODUCT FOCUS

BOILERS OPTIMIZE FUEL EFFICIENCY

Designed with energy efficiency in mind, several new boilers and package boiler systems are now available that include superheated, saturated, mobile and deaerator options.

All boilers are equipped with steam pressure gauges, low water cutoffs, safety valves, FW stop and check valves. They also include blow down valves, a chemical feed valve, FW regulator with pre-piped three valve bypass, BMS/combustion controls, and complete fuel train and pilot ignition system. A forced draft fan, motor and starter, steam non-return valve, stack, water column and site glass complete these units.

The newest inventory includes several skid and trailer-mounted superheated and saturated boilers for temperatures up to 750°F, pressures up to 800 psig and steam ratings to 90,000 pph. Also available are 300-hp, 250-psig mobile boiler rooms and 85,000-pph deaerators with enclosures.



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Better Understand Boilers

A number of factors affect selection, performance, reliability and safety

By Amin Almasi, mechanical consultant

Steam finds wide use in chemical processing for applications ranging from heating fluids to driving equipment. The boilers that generate this steam from water come in many different varieties and sizes. So, here, we'll look at the types and designs of boilers for process plants, as well as issues related to their safety, reliability and efficient operation. We'll also discuss accessories and condition monitoring.



Dried steam is essential for many applications.

First, let's go over some basics. Only purified water should serve as boiler feed water (BFW). The water may flow through, e.g., horizontal, vertical or spiral-wound tubes. The tubes may be smooth, ribbed, etc. Boilers rely on a combination of radiant and convective heat transfer; they consist of a furnace (hot gas) section and steam-containing parts (tubes, etc.). A lower mean temperature difference between the hot gas and the steam usually mandates an increase in the surface of tubing and boiler weight. High temperature boilers require special alloys such as nickel-based ones for their hot section.

Designers strive to optimize heat transfer and, thus, efficiency. Higher efficiency reduces the fuel input and the combustion product mass rates, which also means less pollution and emissions. It also translates into a smaller size boiler.

VARIANTS

Boilers come in many different types and designs. A commonly used configuration

uses a steam drum. In this type, the water enters the boiler through a section in the convection pass called the economizer. From the economizer, it passes to the steam drum. Once there, the water travels via downcomers to the lower inlet water-wall headers. From these headers, the water rises through the water walls and eventually changes into steam due to the heat generated, for instance, by burners. This steam enters the steam drum. It moves through a series of steam and water separators and then dryers inside the steam drum. These remove water droplets from the steam and then the cycle through the water walls is repeated. Forcing the water to the boiler usually requires a special set of feedwater pumps.

Many large boilers have a steam drum and use water tubes embedded in the walls of the furnace combustion zone; these units come in different layouts and arrangements to allow picking a configuration offering the best efficiency for a specific application. The saturated

steam from the steam drum flows through tubes heated by the hot combustion gases, becoming superheated. The hot gases also preheat the steam entering the steam drum and the combustion air going into the combustion zone.

Another variant is a simpler design known as a once-through boiler. This system has no steam drum. The water goes through the economizer, the furnace wall tubes and the superheater section in one continuous pass; there's no recirculation. Here too, a set of feedwater pumps supplies the motive force for the flow through the boiler.

Dried steam is essential for many applications. For instance, any droplets of liquid water carried over into a steam turbine can produce destructive erosion of the turbine blades. Therefore, the boiler system must generate dried superheated steam.

SUPERCRITICAL ONCE-THROUGH BOILERS

At the critical point of a fluid, distinct liquid and gas phases don't exist and there's no phase boundary between liquid and gas. As the critical point is neared, the properties of the gas and liquid phases approach one another. At the critical point, only one phase exists, a homogeneous supercritical fluid. Some engineers call systems using this approach steam generators, not boilers, because they don't actually boil water. However, the term boilers is widely used for

them and, so, we'll refer to them as boilers in this article.

For large supercritical steam boilers, the once-through configuration is the preferred option as there's no need for a steam drum or similar provisions because separate liquid and gas phases don't exist.

A supercritical steam generator operates at pressures above the critical pressure, say, around 220 Barg. Liquid water immediately becomes steam. The efficiency of the overall operation exceeds that of a subcritical steam system.

Other factors also favor supercritical once-through boilers. For instance, by obviating steam drums, these systems avoid the problems and potential incidents (including catastrophic explosions) often posed by steam drums.

Such systems typically involve water entering the boiler at a pressure above the critical pressure, getting heated to a temperature above the critical temperature (say, to 375°C) and then being expanded to dry steam at some lower subcritical pressure. This can occur via different configurations, for instance, a throttle valve located downstream of the evaporator section of the boiler.

Many supercritical once-through boilers used in plants have pressures in the range

Think of the safety valve as the last line of defense.

of 250–350 Barg and temperatures of 500–650°C, well above the critical point of water. However, opting for more moderate conditions, say, just above 240 Barg and 500°C, reduces operational complexity and improves reliability. The high-pressure steam generated can undergo step-by-step reduction to provide medium- and low-pressure steam if needed.

The primary disadvantage of supercritical steam boilers is their need for extremely pure BFW, say, on the order of about 0.1 ppm by weight of total dissolved solids (TDS). Another challenge is operation at part load. At full load, the mass of fluid in the tubes avoids excessively high temperatures. However, at part load, the lower volumes of delivered water and generated steam raise the chance of overheating.

So, an important consideration is how the boiler would operate at partial water flow. A traditional method of part-load operation uses sliding pressure control, with

progressive reduction in operating pressure, to minimize temperature variation of the generated steam. When the pressure in the furnace-wall tubes drops below the critical pressure, the mass required to avoid overheating increases dramatically. For this reason, a number of boilers operate with the furnace walls at full pressure and superheaters operating under sliding pressure. This arrangement relies on a number of throttling duty valves, which can affect plant reliability, availability and maintenance requirements.

Some boilers instead use a spiral-wound furnace, with inclined tubes as opposed to vertical tubes. Such an arrangement reduces the number of tubes in the furnace and, hence, raises the fluid mass in each tube. At the same time, it increases the individual tube length; each tube passes through every part of the furnace heat transfer surface. This smooths out variations in heat input between, for example, mid-wall and corner locations because each tube passes through both regions.

Many different options exist for dealing with part-load operation, with the proper choice depending upon the specific boiler application.

SAFETY, RELIABILITY & OPERATION

Each year, numerous boiler accidents and failures occur. Most stem from malfunction of different parts, error in operation, poor maintenance, corrosion, etc. Properly functioning control and safety devices are absolutely essential. In addition, you must establish and enforce regular testing and verification regimes to provide confidence the safety and control features will work when needed.

Safety or relief valves usually serve as the primary safety feature on a boiler; these valves prevent dangerous over-pressurization. Safety valves are required in case there's failure of pressure controls or other devices designed to control the firing rate. If something goes wrong, the safety valve is designed to relieve all the pressure generated within the boiler. So, you should think of the safety valve as the last line of defense. It should have sufficient relieving capacity to meet or exceed the maximum burner output. Several factors, such as internal corrosion, restricted flow, etc., can impede the ability of a safety valve system to function as desired. Internal corrosion is probably the most common cause of freezing or binding of safety valves. Keep

all safety valves free of debris or foreign materials and test their operation regularly. It's not good practice to operate a boiler too close to the safety valve setting. This may cause the valve to leak slightly, resulting in an internal corrosion build-up that eventually will prevent the valve from operating. As a very rough indication, a boiler's steam pressure often is maintained at approximately 75-80% of the safety-valve set pressure.

Water flow or level control and low-water fuel cut-off usually serve as the other important control and safety features of a boiler. These devices perform two separate functions. However, on very simple and small boilers, they often are combined into a single unit that provides both a water control function and the safety feature of a low-water fuel cut-off device. However, for many boilers, two separate sets of devices should handle these two functions. Usually, a boiler, particularly a medium or large one, should have two independent low-water fuel cut-off devices (a primary and a secondary). Many codes and jurisdictions require two such independent devices on steam boilers.

Modern fuel systems for boilers are complex assemblies, consisting of both electronic and mechanical components. Many things can go wrong with a boiler's fuel system. For instance, ignition transformers may deteriorate or fail; ignition electrodes may burn and become coated; fuel strainers

and burner equipment may clog up; fuel valves may get dirty and leak; air/fuel ratios may drift out of adjustment; and flame scanners may become dirty. A fuel system should incorporate many safety features. The burner system, in particular, requires periodic cleaning and routine maintenance. Failure to maintain the equipment in good working order could result in many problems such as excessive fuel consumption, loss of heat transfer or even an explosion.

The flow of water in different parts of the boiler as well as the temperature profile in the furnace and hot gas sections demand care; these are key operational parameters that require measurement. For example, stack temperature reflects the temperature of the flue gas leaving the boiler. A higher-than-usual stack temperature indicates the tubes may be getting a build-up of soot or scale and inefficiencies exist in the heat transfer regime.

The majority of boiler troubles, failures and accidents are avoidable. One of the most effective tools to prevent such problems is condition monitoring. Most boiler problems and issues don't occur suddenly but develop slowly over a long period of time. The best way to detect important changes that may otherwise go unnoticed is to comprehensively record condition data and carefully evaluate those data periodically.

For the best performance, safety and reliability, maintain the fire in the furnace section as uniformly as possible to avoid an excessive rate of combustion, undesirable variations in temperature, and possible explosions. The destructive force in a boiler explosion comes from the instant release of energy whether in combustion system or steam sections. ●

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Consider a Thermocompressor

This unit offers potential opportunities for improving energy efficiency

By Alan Rossiter, Energy Columnist

I first encountered a thermocompressor as a young process engineer working at a multiple-effect salt evaporation plant. The device sat at the back of the plant, blending medium-pressure steam (MPS) and low-pressure steam (LPS), to provide intermediate-pressure steam (IPS) for the evaporation train. In the years since then, I've found many other uses for thermocompressors. They are used commonly to



The thermocompressor allowed us to maximize power generation, and thus minimize net steam cost.

satisfy a demand for steam at a pressure that's slightly higher than one of the header pressures in the site's central steam system — generally the low-pressure (LP) header. In most cases, the end user of the steam is a reboiler for a distillation column.

So, what is a thermocompressor, and how does it help us improve energy efficiency?

Bernoulli's Theorem is essentially an energy balance for flowing fluids. In its simplest form, it can be written as: $p + \rho v^2 / 2 = \text{constant}$, where p is the pressure of the fluid, ρ is its density, and v is its velocity. In this form, the equation assumes the fluid is incompressible, which actually applies only to limited cases. However, it does illustrate the key principle of the thermocompressor: assuming no energy enters or leaves a fluid, its pressure falls when its velocity rises, and vice versa.

A thermocompressor consists of a metal casing with three main parts: a motive steam nozzle, a mixing chamber and a

diffuser. With no moving parts, it's generally a low-maintenance item.

In the evaporator example, the steam that drives the compression (MPS) is called "motive steam;" the steam that's compressed (LPS) is called "suction steam," and the combined effluent (IPS) is the "discharge steam." The motive steam enters the thermocompressor through the motive steam nozzle, where it expands and accelerates into the mixing chamber. Due to its increased velocity, we know from Bernoulli's Theorem that the motive steam's pressure drops. It reaches a pressure below that of the suction steam, which is drawn into the mixing chamber. The two steam streams intermingle, and the combined flow enters the diffuser, where the velocity falls. The pressure therefore rises, and reaches its discharge value, which lies between the motive and suction pressures.

The same principles also apply to steam jet vacuum systems. These also use steam as

the motive medium; however, in this case the suction load is usually either air or a process vapor, at a pressure below ambient.

The usefulness of thermocompressors is tied to the interface between central steam systems and process plants. For example, the utility plant for our salt evaporators also served several other plants, and it provided high-pressure steam (HPS), as well as MPS and LPS. The HPS came directly from the boilers — but the MPS and LPS were obtained by passing HPS through steam turbogenerators. These produced electricity, which reduced the amount of expensive power we had to import from the grid. Our salt evaporation system required a pressure between the MPS and LPS levels. We could have supplied this by passing MPS steam through a pressure-reducing valve, but this would have lost the very significant benefit of power generation between the MPS and LPS pressure levels. This thermocompressor allowed us to maximize power generation, and thus minimize net steam cost.

The steam system at our site was well-balanced, and we didn't often vent LPS. However, there are many sites where LPS venting is a constant problem. In such cases, the LPS used in a thermocompressor reduces the LPS vent. This is usually more valuable than increasing power generation.

Thermocompressors also can be used to compress low-pressure flash vapor. The vapor can be obtained by flashing steam condensate or by flashing an aqueous process stream [1]. On its own, the flash vapor isn't at a high enough pressure to be useful. However, the thermocompressor, can boost it to a pressure for use in process applications such as stripping or reboiling for distillation columns. In this way, "waste heat" can become "useful heat."

However, the practical range of operability for thermocompressors is limited. The percentage of suction steam in the mix decreases as the discharge pressure increases. As a rule of thumb, a thermocompressor can only be justified if the motive:suction flow ratio less than 2:1. In a typical MPS/LPS thermocompressor, this would deliver a discharge pressure about 2 bar higher than the LPS (suction) pressure. ●

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Forestall Steam System Outages

Understand your temporary boiler requirements and plan ahead to minimize downtime

By Tim McBride, Nationwide Boiler Inc.

Steam plays a prominent role in many chemical, manufacturing, refining and other industrial processes. When a boiler goes down, companies can be faced with a potential loss of hundreds to thousands of dollars for each minute of lost production time.

The best time to plan for an emergency is before one arises. Although many plants operate 24 hours per day,



seven days a week, without interruption, the likelihood of requiring a temporary steam plant at some point in time is 100%.

Many factors in steam plant operation determine the reliability and availability of steam supply. A temporary steam plant can be required for a number of reasons, including emergency repair, planned maintenance, increased capacity requirements, equipment retrofits and even research and development projects. It is important to be prepared for all possibilities, planned or unplanned, that can cause a production disruption.

Plan ahead and follow this guide when preparing for a temporary steam plant rental.

KNOW WHAT'S AVAILABLE

Take a moment and imagine one or all of your facility boilers has to be taken out of service unexpectedly. What steam capacity would be required to continue positive production? Whatever the amount, that is your sweet spot and the minimum capacity that you should plan for when sizing your emergency boiler. You need to determine the capacity requirement (lb/hr or hp) ahead of time and provide it to the supplier for proper rental boiler selection.

Most dedicated rental companies have boilers in a range of sizes and configurations. The three major types of rental boilers on the market are:



INTERNAL VIEW OF MOBILE BOILER ROOM

Figure 1. This trailer-enclosed mobile boiler room contains a fire tube boiler and all necessary auxiliary equipment.

- **mobile steam plants/mobile boiler rooms** (Figure 1) that consist of a fire tube boiler and all necessary auxiliary equipment, mounted on a trailer or in an enclosed, semi-trailer van.
- **trailer-mounted boilers** (Figure 2), typically water tube, mounted to a dedicated trailer for mobility.



TRAILER MOUNTED BOILERS

Figure 2. The typical configuration of an open-trailer mobile steam plant consists of a water tube mounted to a trailer for mobility.

- **skid-mounted boilers** (Figure 3), both fire tube and water tube, which require cranes for offloading and placing at the jobsite.

Generally, fire tube rental boilers range in size from 50 to 1,000 hp, while water tube rental boilers are larger, ranging from 30,000 to 250,000 lb/hr. In addition, water tube rental boilers (Figure 4) can be built to supply either saturated or superheated steam. You often can rent multiple boilers in parallel to meet your desired capacity if one unit is not sufficient (Figure 5).

Most rental boiler systems will consist of the following items: boiler, burner, combustion controls, safety valves, forced-draft fan and motor with starter, blowdown valves, feedwater stop and check valves, feedwater controls, steam gauge and other trim, flame safeguard system, nonreturn valve and trailer (unless skid-mounted). The customer



SKID-MOUNTED UNITS

Figure 3. Installing these two high-pressure, skid-mounted deaerators rental units required cranes for offloading and placing at the jobsite.



WATER TUBE BOILER

Figure 4. This 200,000-lb/hr package water tube boiler is ready for a long-term rental overseas.

or installer furnishes the piping and other items required for installation.

NOTE YOUR OPERATING REQUIREMENTS

The supplier also will need to know operating pressure, fuel source and available power to provide the correct equipment for your process.

Most rental boilers can fire on natural gas, #2 oil or propane. Burners often can be configured to run on refinery and other fuels, as well, but also consider increases in emissions and other operational effects.

Be sure to note your power requirements to ensure you have enough supply for the rental boiler. Rental boiler systems commonly are configured with a 480-V single-point connection.

Your supplier also will ask about:

- **Steam temperature:** Does your process require saturated or superheated steam?
- **Available gas pressure:** Your supplier can provide a stand-alone gas regulator if the incoming pressure is higher than that required of the rental boiler.
- **Water source and treatment plan:** Suppliers need to ensure that the water going into the boiler has been treated properly to avoid damage to the internals.

DO YOU NEED AUXILIARY RENTAL EQUIPMENT?

Water treatment is vital to the life of a boiler, be it a permanent system installed in your facility or a temporary boiler that eventually will be removed.

If your support equipment is down or is in a location distant to the rental boiler, you



MULTIPLE BOILERS INSTALLED IN PARALLEL

Figure 5. Five 75,000 lb/hr trailer-mounted superheated steam boilers with Urea-based CataStak selective catalytic reduction systems are installed in parallel.



FEEDWATER TRAILER

Figure 6. This application required temporary installation of two 82,500-lb/hr boilers and a mobile feedwater trailer.

should inquire about additional equipment rentals to complete the steam plant. Most companies maintain ancillary equipment to support their rental boiler fleets. This rental inventory might include mobile feedwater trailers (Figure 6), high-pressure deaerators, water softening systems, blowdown heat recovery units, selective catalytic reduction (SCR) systems and economizers.

Working with a company that maintains both rental boilers and support equipment will ensure that you have a plethora of options when equipment is down.

FIND A PLACE TO SPOT THE BOILER

The temporary boiler's location should be easily accessible to all required utility connections (water, fuel and power) and able to support the boiler's weight. Compare site and equipment dimensions and watch for obstructions that can hinder the rental boiler's entry. Keep in mind that a

skid-mounted boiler rental unit may require a special foundation in addition to crane handling and special rigging.

FACTOR IN TRAVEL TIME

Shipping large equipment can take time, so be sure to factor in the length of time it will take to ship the equipment to your facility. Some suppliers offer pre-permitted trailer-mounted boilers for shipment; however, every state has different permitting requirements. Loose items such as gas regulators, economizers and auxiliary equipment may require a separate flat bed for shipment.

Finding a supplier with multiple storage locations for its rental equipment



WEATHERPROOF ENCLOSURE

Figure 7. This package water tube rental boiler includes a temporary enclosure for temperature conditions at or below freezing.



NOX COMPLIANCE

Figure 8. This application required temporary installation of one trailer-mounted package water tube boiler and CataStak SCR system for sub 5ppm NOx compliance.

can minimize transportation costs and travel time.

BOILER MAINTENANCE AND WEATHERPROOFING

To ensure continuous, safe and trouble-free performance, daily checks and routine maintenance must be performed during the rental equipment's normal operation. This includes inspection of all safety devices and low-water cutoffs during every shift. Feed-water treatment and blowdown services also must be performed to ensure proper boiler performance.

If you live in an area with freezing temperatures, prepare to weatherproof your rental

boiler (Figure 7). If you don't, be aware that you will be responsible for any repairs freeze damage causes. The rental boiler supplier should be able to provide you with maintenance instructions as well as freeze protection recommendations before your rental.

FIND A LOCAL CONTRACTOR FOR INSTALLATION

Boiler rental companies provide the rental equipment but typically do not install it. Find a local reputable contractor with boiler installation experience to install your rental equipment. The rental company will supply detailed drawings and data to aid the installation.

LEARN LOCAL CODES AND PERMITTING REQUIREMENTS

Both construction and air permits are required by every state before installing a rental boiler, and the requirements differ by state. Check with your local permitting offices and get the equipment permitted before taking delivery on your rental boilers. Some permits take months to process.

If your emissions requirements are 15 ppm NO_x or less, look for a supplier who can offer an SCR system rental or an ultra-low NO_x boiler (Figure 8). If an SCR system is required, and your company is opposed to the use of ammonia, find a supplier that maintains a fleet of both ammonia- and urea-based SCR rental systems.

BE AWARE OF VENDOR VS. CUSTOMER RESPONSIBILITIES

In addition to finding an installing contractor and obtaining permits, the customer is responsible for providing piping and utilities, determining emissions and other site requirements and installing freeze protection as needed. The rental boiler company generally will require a signed rental agreement, purchase order, deposit and proof of insurance coverage before delivery takes place. A well-written rental agreement will carefully outline customer responsibilities and liabilities.

Most rental boiler suppliers provide additional services for their customers as needed — rental equipment engineering services, accessories, drawings and specifications, shipping arrangements, operation and maintenance manuals, start-up technicians, operator training and full-time operators.

DO YOUR RESEARCH

Choosing a reputable and reliable rental boiler supplier may be the most important step in this process. Decision-makers should take some time to research suppliers that maintain their own fleet of mobile steam boilers specifically for temporary use. Furthermore, taking the time to visit your chosen supplier can provide valuable intel on its equipment, capabilities and quality of workmanship.

Last, be sure to consider whether the company is a full-time, dedicated rental

company with experience, reliable equipment and the capabilities to handle your project. Be cautious of firms that claim to be reliable and offer low-market pricing.

The preparation time required to create a contingency plan is minimal when

compared to the possible production, time and money lost when an emergency arises. As the saying goes, hope for the best but plan for the worst. It will be well worth it in the long run. ●

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Properly Calculate Steam Needs

When heating process water for jacketed vessels, use these equations for proper operation

By Phil Hipol, Pick Heaters, Inc.

Steam is capable of transferring a large amount of heat to materials used in chemical and pharmaceutical processing; it precisely can be controlled to within narrow temperature ranges. It can be applied directly to the materials being heated (through direct steam injection or DSI), or indirectly through the use of heat exchangers that incorporate plates or tubes to segregate steam and process



fluid. Depending on the application, each technique has its advantages and disadvantages. The various applications for steam injection heating include production of hot water for jacketed vessel heating, batch water heating, slurry heating, clean-in-place and sanitation.

The amount of steam needed for these operations can be easily calculated. For heating a product in batch mode, the material (usually a liquid) is placed in a steam jacketed tank (Figure 1). The average heat transfer rate for the steam is governed by the fundamental conduction heat transfer equation:

$$\dot{q} = \frac{mC_p\Delta T}{t}$$

Where: \dot{q} is the average heat transfer rate (kJ/sec);

m is the mass of the material that is being heated (kg);

C_p is the specific heat of the material to be heated (kJ/kg °C);

ΔT is the required increase in temperature of the material to be heated (°C); and

t is the total time over which heating occurs (sec).

The mass (m), temperature (ΔT) and time (t) are process parameters, and value(s) of specific heat (C_p) can be obtained from tables for common [liquids](#) or [solids](#). For



DIRECT STEAM INJECTION SYSTEM

Figure 1. This direct steam injection system heats a jacketed vessel.

reference, the specific heat of fresh water is 4.19 kJ/kg-°C (or 1 BTU/lb-°F). Heat transfer is dependent on ΔT across the jacket and effective surface area. Transfer is greatest at the start of the heating cycle, steadily diminishing as product temperature increases. When selecting the steam flow control valve and trap, both extremes must be considered.

For heating of a material that is flowing, the heat transfer equation becomes:

$$\dot{q} = \dot{m}C_p\Delta T$$

Where \dot{m} is the mass flow rate of the material (kg/sec).

Knowing the heat transfer rate (\dot{q}), it is possible to calculate the mass of steam needed by:

$$m_s = \frac{\dot{q}}{h_e}$$

Where: m_s is the required mass flow rate of steam (kg/sec);

h_e is the steam evaporation energy or latent heat (kJ/kg) when using an indirect exchanger; and

h_e is the total steam energy – energy of inlet fluid when using a DSI heater.

For a given temperature and pressure of steam, the evaporation energy and total energy (h_e) can be obtained from a [saturated steam table](#). For example, 8 Barg saturated steam has an evaporation energy or latent heat content of 2,033 kJ/kg and total heat content of 2,773 kJ/kg. Once the required mass flow rate (m_s) of

the steam is known, it will be relatively straightforward to select the range of steam heating products that could be employed from a catalog, based on the specific application.

The difference in useable heat is one of the advantages of DSI. Following condensation, heat transfer continues until temperature equilibrium is reached between the condensate and product. When using a heat exchanger, only latent heat is transferred. Condensate is rapidly expelled before any further transfer can occur. Heat transfer is limited by average ΔT between steam and product and effective surface area. Heat transfer can be increased by increasing steam pressure and temperature, but at the cost of increased flash losses and decreased thermal efficiency.

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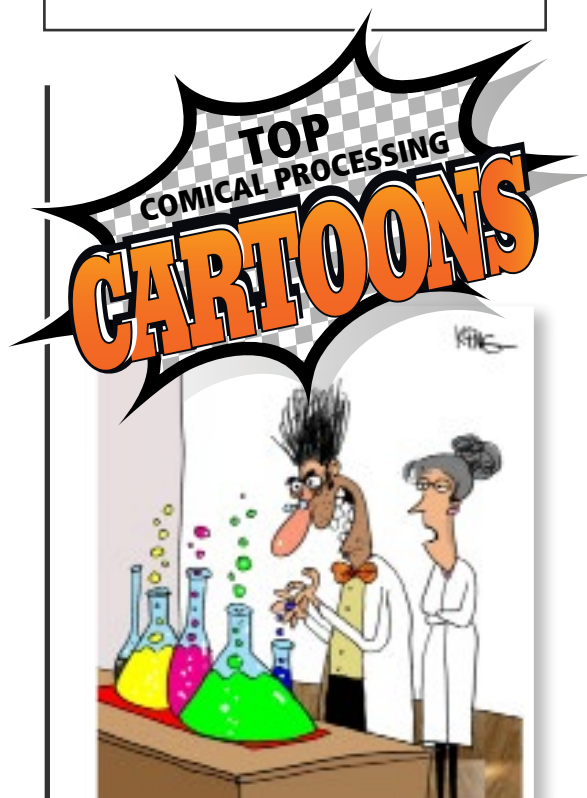
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