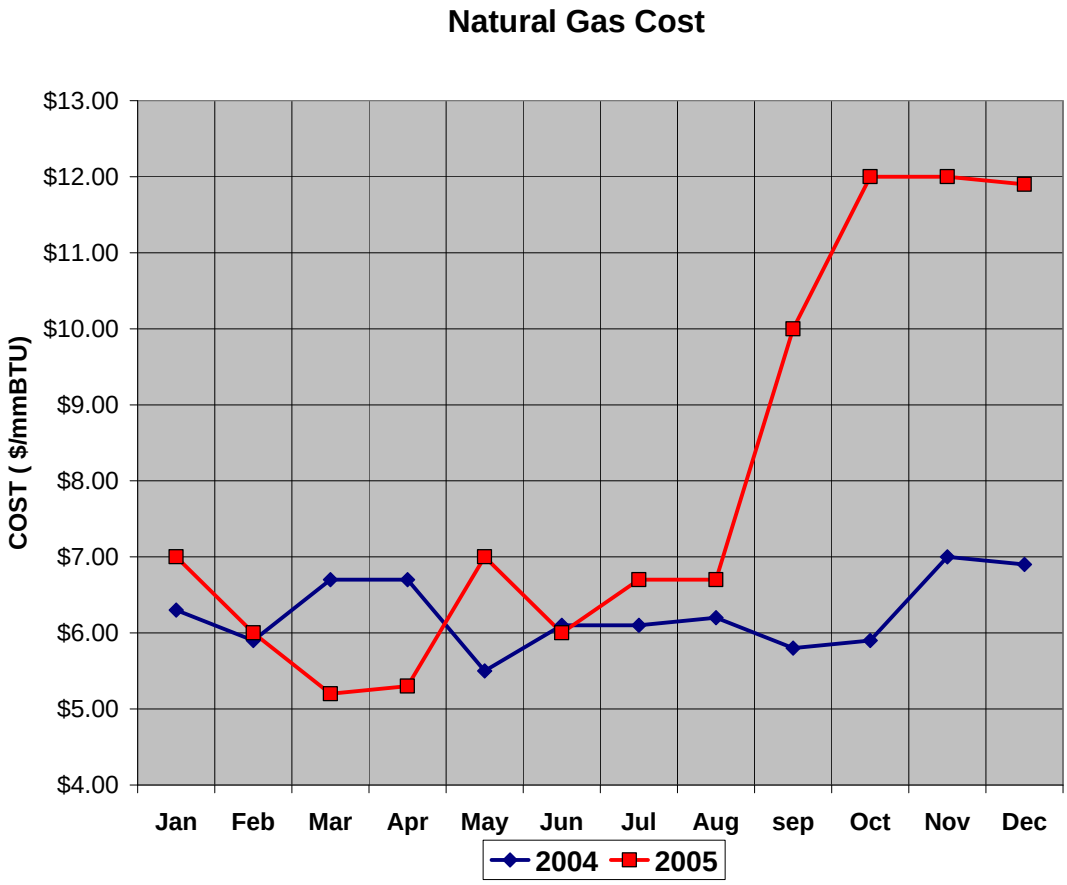
Reduce your
RTO (Regenerative Thermal Oxidizer)
Fuel Consumption by as Much as 60%

By Rodney L Pennington, PE
rpennington@durrusa.com 407-496-1911
And Carol Stanley
cstanley@durrusa.com 734-254-2429

Up grading your RTO system with the latest energy enhancement features can provide a simple pay back of less than one (1) year.

As most panel board plant manager have already realized, the cost of natural gas has gone through the ceiling, and their RTO air pollution control equipment is burning up their board production profits faster than they can produce them.



Natural gas costs have nearly double in the past year and it is expected to continue to increase in the years to come. Now is time to get an energy analysis of your existing

RTO system to establish how it can be up graded to a much more efficient system. A typical old style 120,000 SCFM RTO unit, operating 8000 hours a year, costs over **$1,600,000 a year at today's natural gas cost.**

- 1.08(120,000scfm) (110 ^{o}F delta T) / 0.85 available energy = 16,770,000 mmBTU/hr
- 16.77 ($12/mmBTU) = $201/hour
- 8000 hr/yr ($201/hr) > $1,600,000 per year

A simple energy audit and/or inspection of the RTO unit can identify a series of potent modifications and/or up grades that will pay for themselves and provide **continued savings** as much as **$900,000 per year** on a typical 120,000 SCFM RTO unit. They include:

- **$** Process flow reductions..... ~ $13,000 per each 1,000 SCFM
- **$** RCO Conversion..... $560,000 to $1,100,000 savings
- **$** Fuel Enhancement System (FES patent pending)... $240,000 to $400,000 savings
- **$** On line Bake out..... up to $500,000 savings
- **$** Combustion air adjustment
- **$** Pre-filtration
- **$** Controls Tuning up

Energy Audit / Inspection

A typical energy audit/inspection costs approximately $3, 000 to $7,000. Inspections are the first line of defense to ensure your system is running at optimal conditions and complying with environmental laws and regulations. Even well-designed systems require reconditioning or will benefit from upgrading to maintain efficient operation. Reconditioning makes sense when the system's components show excessive wear, resulting in reduced destruction efficiency and/or increased operating costs from excess energy consumption. Inspections include a detailed recommendations and options for forward planning.

Inspections can be provided with the system on-line and/or off-line. Inspections focus on all of the potential areas for energy savings and the adjustment and condition of the flow control valves. These valves are the heart of any RTO/RCO system, if they don't work properly, the whole system does work. Other key components inspected include the wearable components, heat recovery media, cold faces, insulation, fans, burner system adjustments and controls.

The benefit of the on line inspection provides details on the operating temperatures and pressure drops to verify the current utility costs and the potential energy savings.

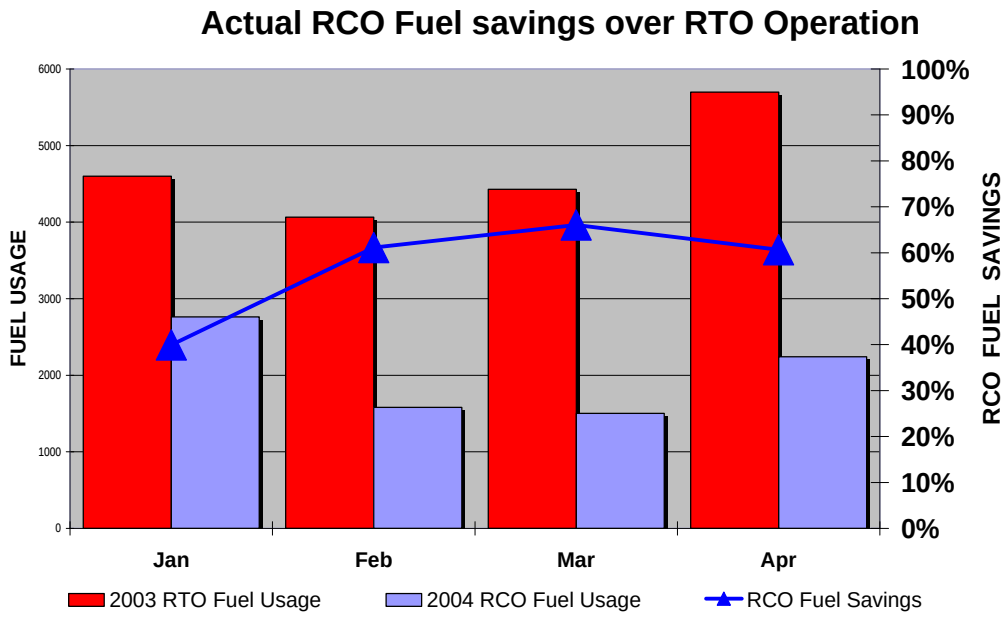
PROCESS FLOW REDUCTION

Insure that the exhaust flow from the process is minimized;

- o up grade the press PTE capture system and add possible Multi-Stage features(patent pending)
- o evaluate recirculation and or cascading with the overall energy plant, dryer and air pollution control equipment to minimize the flow to the RTO
- o In sure that all air infiltration leaks have been eliminated or minimized.
- o tune the burner system
- o And inspect, adjust and/or modify the RTO purge and/or flushing system to minimize flow.

RCO CONVERSION

If the RTO is not operating on a direct wood fire process, the odds are very good that it can be up graded to an RCO system. The associated fuel consumption can be reduced by 35 to 70 % **($560,000 to $1,120,000 per savings)** and the electrical usage by as much as 20 to 35%. This is an excellent option for presses, indirect fired MDF, PB, or veneer dryers



The RCO unit utilizes a catalyst media in conjunction with the regenerative heat exchange media to promote the oxidation of HAPs and VOCs at a much lower purification temperature, typically 800 to 850 ^{o}F, as compared to 1550 to 1600 ^{o}F with the RTO unit. The catalyst is located on top of the RTO heat recovery media and depends on a **uniform flow** through the catalyst at a specific space velocity and entry temperature in order to achieve the desire DRE (destruction removal efficiency).

Uneven air flow through the RCO heat recovery bed will alter the temperature profile of the heat recovery bed which can cause portions of the process air flow to enter the catalyst below the design purification temperature. This causes incomplete combustion and the potential for increased emissions and additional fuel costs. The uneven flow can also increase the velocity through portions of the catalyst media which will have the same effect as the lower entry temperature into the catalyst. **Uniform flow through the heat recovery bed and catalyst is essential** for an RCO ... and the flow control valves, inlet duct, and cold face chamber design is a key factor.

Large RTO chambers as typically installed in the wood industry may require modification, and/or addition features to insure that air flow meets the uniformity necessary for the catalyst to achieve the desired performance.

A catalyst retrofit can be installed in 2-3 days on a typical sized RTO for Wood processes.

Fuel Enhancement System (FES)

If the RTO is operating on a direct wood fired dryer, a Fuel Enhancement System that incorporates **enhanced and intrinsic safety features** that meet FM 6-11 requirements and can be added to the RTO. The FES will provide a potential 15 to 25% **($240,000 to $400,000 per year**) fuel savings over a standard RTO burner operation.

Normal operation of the RTO utilizes a mixture of combustion air and fuel continuously injected into the combustion chamber through the burner system. The air and fuel are premixed and ignited to generate the actual burner flame and associated energy release. Unfortunately, the high temperature flame increases the potential for NOx and the energy must be thoroughly mixed with the entire process steam to achieve uniform heating and complete combustion.

The burner excess combustion air and the products of combustion exit through the RTO outlet bed to the exhaust stack. Therefore, there is always a greater mass flow-rate passing through the exit recovery bed during the outlet cycle than during the inlet preheat cycle. This mass imbalance reduces the overall effective thermal efficiency of the system, and results in an increase in operating costs, as much as 15% to 25% and also an increase in NO_X emissions.

The FES system, uniformly enhances the energy value of the process steam prior to the inlet preheat cycle in the RTO unit and therefore maintains a uniform heating of the complete process steam as natural gas auto-ignites in the heat exchange media prior to the combustion chamber. The uniform energy release maintains a much lower temperature, reducing NOx and at the same time, utilizes the process stream for combustion air thus eliminating or minimizing the mass imbalance in the heat

exchange media. This increases the overall RTO efficiency and reduces the fuel requirement by as much as 15% to 25%.

The FES can be installed as an integral component of the RTO unit or as an add on system. The FES system artificially increases the BTU value of the process gas stream by adding a premixed air/fuel gas mixture (controlled to less than 25% of the L.E.L.) directly into the process inlet, nearly at the same temperature and prior to the RTO. This additional energy reduces the energy demand on the burners, causing the burners to turn down and run at their low-fire or pilot position. At this position, significantly less combustion air and natural gas is injected directly into the combustion chamber than when the burners run at a normal firing rate. Since the mass imbalance across the heat recovery chambers is virtually eliminated, the measured overall effective thermal efficiency of the RTO unit is markedly improved. Typically, a FES system can reduce the energy consumption by as much as 15 to 25% percent and reduce the NOx by as much as 50%.

A stand alone FES blower and gas train can be installed as an independent package on the inlet of the RTO. The blower pulls a slip stream of air directly from the process ductwork through an optional filter and into a mixing chamber where the air is premixed with natural gas, before it is returned to the process stream. Both the air and gas pressure across the mixing plates are monitored with pressure switches to insure continuous and adequate flow of air at all times. The gas train is set up so that the air to fuel ratio in the exit of the mixing chamber is always less than 25% of the LEL (Lower Explosive Limit). The air/gas mixture is then returned back into the process stream before the RTO unit to maintain an overall mixture concentration at approximately 3% of the LEL, which is the level that will self-sustain the RTO operation at 95% TER.

The additional safeguards of air and gas pressure switches provide the same level of control as the burner system and ensure that the FES air/gas ratios never achieve a level greater than 25% of the LEL. As an added optional and back up safety feature, an LEL monitor can be installed directly downstream from the mixing station to continuously monitor the LEL of the mixture. The LEL monitor will have alarms and shut down control capabilities to shut down the FES system in the event of excessive fuel concentration.

The rate at which the premixed air/fuel is introduced into the RTO inlet stream will be controlled by a modulating natural gas or control valve on the dedicated FES gas train. The valve will respond to either the combustion chamber temperature and/or a signal generated by the LEL monitor. A constant amount of air will be processed through the FES system to insure that the LEL can not exceed 25% even at the maximum gas flow rates.

The FES gas train is FM approved and includes HI and LOW gas pressure switches, double block and bleed valves with proof of closure, venting valve, and also includes a limiting orifice valve that puts a mechanical maximum limit on the rate of gas flow through the train in the event of a malfunction.

In the wood industry, a pressure monitoring and alarm system on the air and natural gas mixing station with automatically shut down the system and alarm with out disrupting the process RTO operation. The mixing station can be easily cleaned with power wash and put back into service in a couple of hours.

RTO/RCO On line bake out

The RTO/RCO on line bake out provides the ability to control organic condensable build up in the heat recovery beds on a more frequent and regular basis, which eliminates or minimizes the loss of thermal energy recovery (TER) efficiency of the RTO/RCO unit. Organic build up in the heat recovery media not only reduces the heat transfer, but causes un-balanced air flow which further reduces the thermal energy recovery... increasing fuel consumption and the associated operating costs. The loss of one (1) percent in thermal energy recovery equates to over **$250,000 per year** in fuel costs on the above example.

In addition, the on line bake out reduces the potential for run away fires that typically occur when the organic build up in the RTO/RCO is excessive.

The on line back out provides:

- on line control of organics without production down time
- maintains full process flow
- more than 90% of the bake out energy is recovered and return to the unit
- the process eliminates the risk of over temperature of the catalyst during bake out
- bake out smoke and emissions are returned to RTO/RCO.
- the bake out exit exhaust temperature is control below the ignition temperature of the duct organic build

Combustion Air Adjustment

The proportioning of air to fuel is often more critical in situations where heat recovery is used. Up grading the air/fuel proportioning controls and/or tuning can a have a substantial affect on the RTO/RCO fuel consumption, especially at today's natural gas costs.

Many of the older RTO/RCO systems have multiple burners operating on a single control loop, which further compounds the cyclic purification temperature control typical of the RTO system due to the cyclic heat recovery chamber operation. Up grading to an individual burner control loop will provide more uniform control and improved thermal energy recovery in an RTO/RCO unit.

A cascade control loop can also reduce the difficulty in tuning the burner system and reducing the cyclic purification temperature and associated loss of energy savings. Many times this can be accomplished with soft ware modifications only.

The **Fuel Enhancement System (FES)** previously discussed can eliminate the combustion air adjustment by minimizing and fixing the combustion air flow, thus providing a very stable and uniform purification temperature.

Pre-filtration Control

If the process exhaust flow contains fly ash, direct wood fired dryers, etc., it is essential that pre-filtration equipment is included prior to the RTO unit to control the fly ash.

The installation of a Wet ElectroStatic Precipitator (WESP) has demonstrated the ability to eliminate or minimize the costly bake outs, wash outs, and heat exchange replacements ever 12-14 months, and provide a substantial energy savings.

Controls Tune up

In addition to the combustion air adjustments, several other controls; valve cycle time, fan pressure/volume control, hydraulic actuator speed control, flushing or purge system, etc, all have an affect on the thermal energy recovery of the RTO/RCO unit.

All of the above features can reduce the RTO fuel consumption, and in many cases include additional electrical savings. The true natural gas savings or lack of savings can easily be observed by the differential temperature across the RTO unit from inlet air to exhaust air temperature. A typical RTO unit, without FES, will operate at approximately 100 to 115 ^{o}F differential temperature.

If your present 95% TER RTO unit is operating at more than 70 to 75 degrees Fahrenheit differential temperature, you are wasting energy and a lot of bucks.