Dramatically cut drying times. Improve head rice yield. Improve quality and drying uniformity. Reduce operating costs. All with the application of a patented new drying system from Catalytic Drying Technologies LLC.

**An Age Old Problem** – For as long as rice has been dried commercially, dryer operators have had the challenge of drying their rice without losing yield.

Simply stated, rice cracks if dried too quickly with heated air. Standard column driers blow heated air through a moving column of rice, usually across the column. Drying occurs through convection and conduction. The heated air warms the outside of the rice kernel and causes moisture from the rice to evaporate from the kernel’s surface (husk) into the dry air. As the rice warms and moisture is removed from the outer layers of the grain, moisture and temperature gradients are established within the kernel. Further, the rice is unevenly heated across the column, even when baffles and mixers are used. This causes temperature and moisture gradients between kernels. These gradients cause stresses in the grain which then cause the rice to break during milling.

Conventional rice dryer operators know this, and work hard to slow down the process. Typically this is done using low heat, long drying times, and many hours or days between drying passes. It can take as many as 4-8 drying passes and a period of several days of “tempering” to get the rice to stable storage moistures, bringing green rice down from field moistures of 18-25% to less than 13% (in the Southern US) or 14% (California).

**Better Technology Discovered 45 Years Ago!** – Heat is transferred in three ways – conduction, convection, and radiation. If conduction and convection heating of rice is not optimally efficient, why not investigate radiant heating? That’s what researchers thought many years ago.

Researchers at Texas A&M University published results in 1959 showing dramatic improvement in rough rice drying efficiency and yield using infrared radiation (IR) as the primary source of heat. Infrared radiation is the bandwidth of wavelengths just longer than visible light but shorter than

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microwave and radio waves. It is the heat you feel from sunshine.

More importantly, a narrow band of IR wavelength, from approximately 3-7 microns, the “Far Infrared” range, is absorbed by water and heats the water in rice – not the air, not the hulls.

Applying the proper wavelengths to the rice dries the kernels “from the inside out”. By doing so, the stresses that would normally occur are substantially reduced, heat is transferred very efficiently, and the rice is quickly dried without stress cracking. The Texas A&M researchers were able to dry rough rice samples from over 20% to less than 14% in less than 8 minutes, with head rice yields equal to or greater than control samples. Most notably, this was accomplished without tempering the rice!

Louisiana State University researchers carried this work further with the construction of an “Infrared PreHeat Rice Dryer”.

To quote their premise: “Practically, the problem is one of applying heat to the grain to attain desirable drying rates and to maintain quality during the process.” They add, “On the basis of this assumption, the decision was made to begin with infrared as the preheat source due to its ability to penetrate the grain and to heat more uniformly.”

A pilot scale ceramic heating system was used to preheat rough rice very quickly prior to exposing the rice to drying air.

The results were remarkable. Excellent head rice yields were achieved, even when preheating the rice for as short a time as 2 minutes, up to temperatures exceeding 200 deg. F! Total drying times, including the preheat drying and air drying, were under 25 minutes in many cases.

The results are clear: By preheating rough rice with infrared energy prior to conventional drying, overall drying time is dramatically reduced, with equal or better milling yields than conventional systems.

Unfortunately, use of ceramic infrared is fraught with problems and the commercialization of such systems is impractical. Ceramic systems operate at very high temperatures (over 1500 deg. F), and either heat the ceramic material electrically (inefficient), or are fired with open flame propane or natural gas. Obviously these systems were not practical for commercial application and therefore this marvelous technology has

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2 Faulkner, Macon D., and Wratten, Finis T. “The Louisiana State University Infrared Rice Drier”. Archives, LSU Ag Research Center. Available on request to the author.
not been available to the industry – until now.

**Flameless Catalytic Infrared Dryers from Catalytic Drying Technologies: The Long-Anticipated Breakthrough**

**What is Flameless Catalytic Infrared?**
It’s a technology that’s been available for as long as infrared drying research has been around, but it’s has never been applied to agricultural drying systems. Since the 1970’s, Catalytic Drying Technologies LLC’s parent company, the Catalytic Industrial Group, has provided flameless catalytic heating systems to many industries. Using a proprietary “enhanced platinum catalyst”, natural gas or propane is combined with air, without flame, to produce heat in the form of infrared radiant energy. This “oxidation-reduction reaction” continues without consuming the catalyst, delivering a narrow range of wavelength. The CDT flameless catalytic heaters provide radiant energy primarily in the 3-7 micron wavelength – ideal for the removal of moisture from rice grains.

To maximize the effectiveness of the radiant energy, CDT developed and patented (U.S. Patent 5,893,217) a combined heating and conveying system that optimizes exposure of the rice grains to the infrared energy. The heaters comprise a set of rectangular elements optimally positioned along the length of the conveyor. The conveyor is a flexible bed with cams placed underneath that rotate in such a way as to gently “bounce” the rice grains upward and forward, allowing for very uniform presentation of the rice kernels to the infrared energy while moving the entire mass of rice along the conveyor.

Tests on this system in 2001 and 2002, on tons of green rice, prove that this system delivers the known benefits of infrared drying efficiently, effectively, and with the desired results of high yield and uniform quality.

**Test Data** – In one series of experiments in a small test drying unit placed at a commercial rice dryer, southern grown rough rice was dried from field moisture levels of 22% to less than 13% using a combination of infrared heating and short holding times.

![Test Unit Schematic Diagram](image)

The variables of radiant energy concentration (distance from the rice), maximum loading rates, and rice temperature achieved were adjusted.

Rice was dried in a less than three hour cycle, including preheating and short holding times between heat treatments. Head yields of 62.3% were achieved compared to commercial results of 59% for the same lot. Test results show that preheating the rice for 8-10 minutes, to as high as 140 deg. F., dramatically reduces overall drying times with high yields. Other tests with different drying rates, heating times and holding times produced comparable results.
Tests in 2001, on a test unit with a capacity of 3,000 lbs. of rice, showed that this system is capable of drying rough rice in less than 2.5 hours without tempering, with high yields and uniform product quality.

Commercial Applications –

I. Preheating Green Rice - Because this system is effective in removing moisture from rice at all stages of the drying process, application of this technology is flexible. Preheating green rice prior to the first drying step would reduce field moisture levels by as much as three percent or more depending upon incoming levels, while uniformly heating the grains prior to the first column drying stage. Once the rice is in the column dryer, airflow would be maintained to slowly cool the rice to appropriate storage temperatures rather than continue to heat it. This process effectively cuts out at least one, possibly two passes of drying and dramatically reduces tempering time between drying steps. Since the CDT dryer provides targeted heating at high efficiencies, low fuel rates and minimum airflow, overall operational costs are significantly reduced.

II. Second and Subsequent Pass Preheating - In order to reduce tempering times and subsequent passes, the CDT system can be placed to handle rice from working bins, taking out the difficult lower percentages of moisture uniformly and more rapidly than conventional systems. CDT dryers can be custom sized to handle the flow rate requirements of any drying operation.

III. On-Farm Drying – CDT’s flameless catalytic infrared dryer is ideal for quickly drying rice from the field prior to loading in farm bins. By pre-drying green rice 2-3% and elevating its temperature to approximately 110 Deg. F., rice can be placed in farm bins to be aerated over a shorter period of time. This application can reduce the number of days required for farm-stored rice to be ready for market.

The Economic Value of CDT’s Flameless Catalytic Infrared Dryer System –

Energy costs are directly related to the efficiency by which moisture is removed. In conventional column drying, energy is lost when some of the heat in the drying air is exhausted without being used to evaporate water from the rice. Significant electrical energy is used to power the fan motors.

The Flameless Catalytic Infrared Dryer from CDT is much more energy efficient. The infrared energy directly attacks the moisture in the rice. Small airflows are maintained to remove humidity from the conveyor area. The amount of energy required to dry rough rice in the large scales test was 1,500 BTU per pound of water removed, compared to 1,800 - 2,000 BTU per pound of water removed in column dryers. By cutting overall heating time in half using CDT’s system as a preheat drier, an estimated 25-35% savings on heat energy can be realized. This does not include electrical savings from lower
air handling requirements, which would be at least 50% lower using the CDT preheat dryer.

Energy isn’t the only savings opportunity – operating costs are reduced due to less handling, fewer passes through the equipment, and shorter storage times, all resulting in less maintenance and operating hours for the same volume of rice.

Finally, yield improvements of 1 to 3% are possible using the CDT drying system.
Appendix A. – Equipment Specifications

I. Sizing the CDT Flameless Catalytic Infrared Preheat Dryer – 1,000 cwt per hour throughput (~650 barrels/hour), 2% Moisture removal, preheat rice to 120 deg. F:

- Dryer loading rate: 25 lb. rough rice per square foot conveyor area
- Conveyor width: 10 ft.
- Dryer residence time: 6 minutes
- Capacity per foot of dryer length: 250 lb.
- Dryer length per 1,000 cwt/hour processing rate:
  - Processing rate: 1667 lb. per minute in drier
  - 7 ft. of drier per minute of processing time
  - Drier length: 42 ft.
- Discharge air fan horsepower: 5 hp
- Conveyor horsepower: 25 hp
- Heat required for 1,200 BTU/lb water removed:
  - Input moisture 20%
  - Output moisture 18%
  - Water removed per hour: 5 cwt
  - Heat required: 600,000 BTU/hour
- Natural Gas Fuel Required:
  - 1 cubic ft. – 1,000 BTU
  - 600 cubic ft. NG per hour
- Fuel Cost at $6.00 per thousand cubic ft: $3.60/hour

II. Cost Savings

- Estimated cost savings for total drying of rough rice:
  - Energy Cost Savings: $0.50/cwt
  - Overheads: $0.05/cwt

  For each 1,000 cwt rice processed, these savings equal $550.

  For a commercial dryer operation doing 500,000 cwt/year, estimated cost savings are $275,000.

  These savings do NOT include milling yield improvements of at least 1%, nor do they include reduced maintenance and/or asset reduction (i.e. removal of column dryers and working bins).

III. Capital Cost

Capital costs for the CDT dryer depend on the installation. The approximate price for the 42 ft dryer is $275,000. Add an estimated 50% for installation, conveyors, hookup, etc. Total project estimate ~$400,000. This results in a faster than 2-year payback!