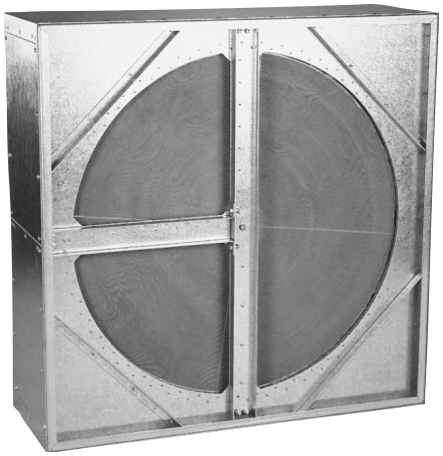
# NovelAire Technologies

## HEAT & MASS TRANSFER PRODUCTS



Desiccant Dehumidification Wheel
Technical Information

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# General Information

## Use

NovelAire Technologies Desiccant Dehumidification Wheels are intended for mass transfer of water vapor for use in desiccant dehumidification and desiccant cooling equipment. For use in this broad range of applications, NovelAire's wheels have been engineered for maximum durability under severe operating conditions.

## Filtration

**Atmospheric contaminants, exposure to acidic gases or airstreams and contact with petroleum based airborne particulates reduce the adsorption capacity of NovelAire desiccant wheels. ASHRAE "30%" rated filters should be used with NovelAire desiccant wheels to minimize the effects of dust and airborne particulates on the longevity of the wheel.** These filters (minimum 2" deep pleated type) should be used for both process and reactivation air streams. Users of NovelAire desiccant wheels should avoid the use of wire mesh type roughing filters, which allow passage for significant dust and particulate matter.

## Longevity

When used with properly selected and maintained filtration (in areas of low ambient pollution), the NovelAire desiccant wheel is designed for 87,600 hours (10 years) of continuous use. This longevity statistic is based on maintaining 90% minimum of full rated performance. Improved filtration may extend the life of the wheel.

## Operating Ranges

The NovelAire desiccant wheel has been designed to provide maximum moisture transfer for a variety of applications within a broad operating spectrum. Consumer designs should consider wheel rotational speed, reactivation/ process face velocity, reactivation configuration and entering conditions (as well as desired leaving conditions) to achieve optimum wheel performance. See "Reactivation Configurations" for more information. NovelAire dehumidification wheels are designed to condition air streams at velocities of up to 1500 feet per minute, temperatures up to 350 Degrees Fahrenheit **(under no condition may 350 Degrees Fahrenheit be exceeded)** and operating moisture levels to saturation. NovelAire desiccant wheels may not be operated with condensate in direct contact with the wheel faces (ie: under "wet" conditions), but may be washed (for cleaning purposes) when removed from the unit. See "Wheel Maintenance" for more information about washing wheels.

## Wheel Types

NovelAire offers three (3) different types of desiccant wheels, each engineered to be commercially produced using quality raw materials. NovelAire's wheel types are tailored to meet today's and tomorrow's diverse needs for a variety of dehumidification and Indoor Air Quality (IAQ) applications.
NovelAire offers :

**Wound Silica Gel (WSG)** wheels are comprised of silica gel desiccant in a high temperature fiber substrate. WSG wheels are generally used for traditional industrial dehumidification, low dewpoint applications, and near saturated air streams.

**LCIX (LCX)** wheels are comprised of a "next generation" 1M desiccant in a high temperature fiber substrate. LCX wheels are used for dehumidification of outdoor summer air and in compact higher reactivation temperature desiccant cooling systems.

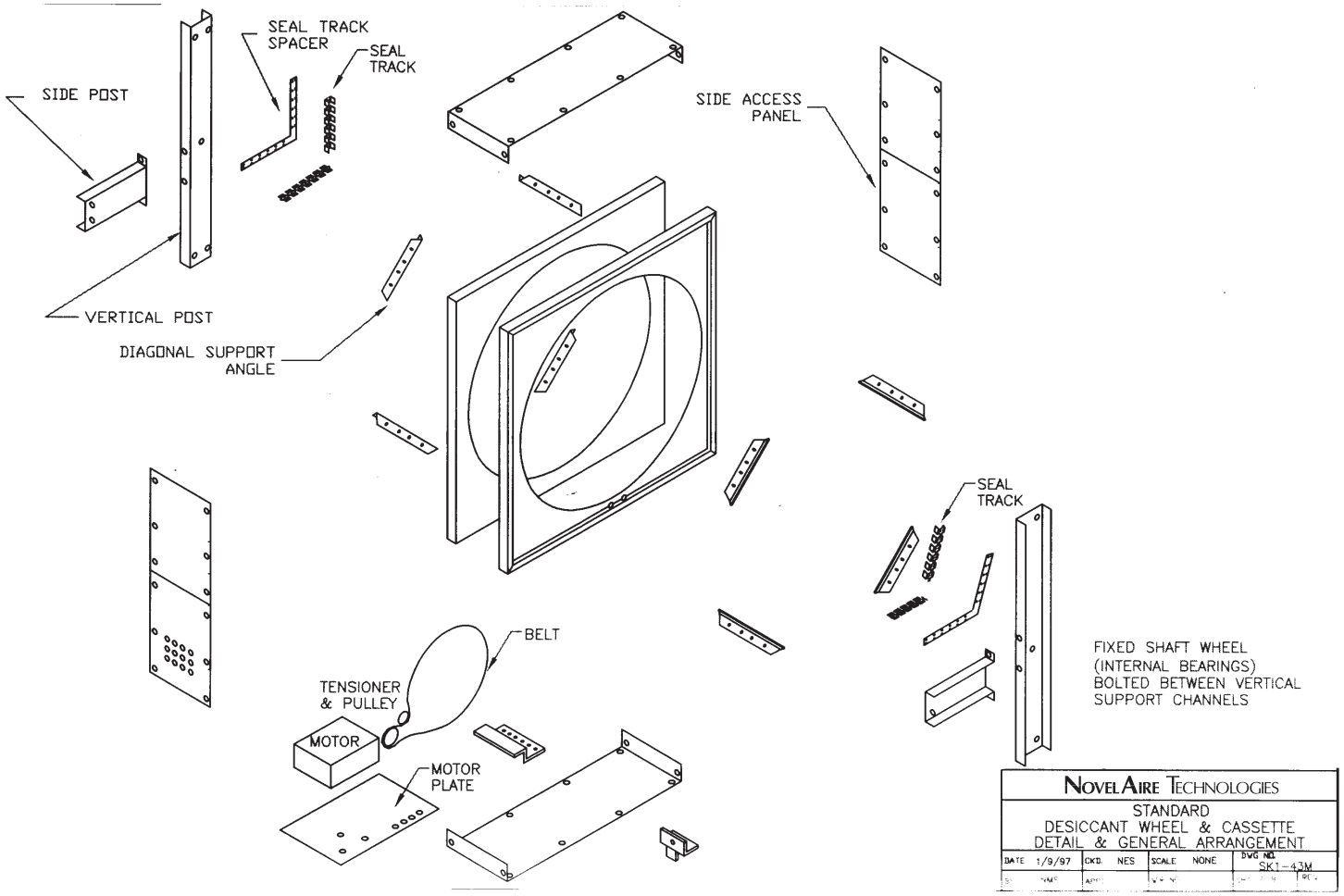
**LT3** wheels are comprised of a high capacity low regeneration temperature "premium" desiccant in a high temperature fiber substrate. LT3 wheels are generally used in commercial desiccant cooling systems, where the availability of lower temperature regeneration energy provides rapid payback.

# Cassette Design

## Construction

Cassette cabinets that house the NovelAire desiccant wheel should be constructed of rigid materials and rated for reactivation heater radiant temperatures, vapor tight integrity, and resistance to vibration. NovelAire uses stainless steel, galvanized steel, carbon steel and aluminum in its own specialty and standard cassette enclosures. Since dehumidification performance is affected by leakage from wheel seals or ambient air ingress, it is essential that air movement, heat and vibration do not distort cassette faces during operation. NovelAire wheels are designed to be center supported, using a fixed bolted shaft and internal wheel bearings. Large cassettes use a rotating shaft with external pillow block bearings. Wheel support channels should be designed for the high density of the desiccant wheel. Consult “Wheel Dimensions, Face areas and Weights” for more information. See “Standard Desiccant Wheel and Cassette Detail and General Arrangement” for a detail of NovelAire’s construction method. Note the use of corner braces, return bends and formed channels used to maximize the rigidity of the cassette and cassette face. This method allows for the more economical use of conventional sheet metal technology (as opposed to welded tube steel or aluminum construction favored by other manufacturers) to provide for flat and consistent sealing and support of the desiccant wheel.

# Example of Cassette Construction



### Wheel Drive Systems

NovelAire desiccant wheels are designed for rotation from applied forces of 15 to 60 pounds at the desiccant wheel circumference. Seal selection and adjustment ultimately determines the total force required for a given diameter. Generally, a maximum of 40 pounds force (lbf) will be required to drive a properly sealed wheel. Starting torque is usually limited to a maximum of 60 lbf. NovelAire uses heavy duty gear motor drives to ensure long drive system life. Drive motor/ gear selection should limit total force applied to the circumference of the wheel at one hundred (100) lbf to prevent distortion of the desiccant wheel outer band. Exceeding 100 lbf at the wheel circumference may damage the desiccant wheel outer band and/ or desiccant media. Additionally, since belts used for standard drive units may stretch and slip in operation or when heat is applied, NovelAire recommends a spring loaded automatic tensioner and chain for use in selected drive systems. Spring tension should also be limited to 100 lbf to prevent wheel distortion and damage as described above. NovelAire uses #40 chain in its standard drive system.

### Sealing Materials

Full contact sealing material utilized at the wheel circumference and reactivation/ process "split" may be of bulb, wiper or flat designs. The NovelAire desiccant wheel has been designed to provide a smooth flat sealing surface compatible with any of the described methods. The wheel faces, as with any brand of desiccant wheel, will wear the installed seals over a period of time, and seals should be Teflon coated to extend longevity. NovelAire recommends the use of a skived Teflon film, minimum 0.007" in thickness, comprised of 75% PTFE, 20% glass fiber and 5% graphite. This combination of materials, applied over a silicone bulb or wiper (with silicone adhesive) has proved to be durable and reliable. Contact NovelAire for more information on Teflon film. Ideally, seals will be selected to provide for minimum leakage at up to 8" w.g. between process and reactivation air streams, while allowing for minimum drive motor power consumption and seal wear. In its standard design, NovelAire uses silicone bulb type seals which have been teflon coated at the reactivation to process "split," and are graphite coated at the wheel circumference. Seal selection and adjustment should allow for wheel rotation within the parameters described in "Wheel Drive Systems."

## Reactivation Configurations

### Orientation

NovelAire desiccant wheels are designed to be operated with either 25% area for reactivation and 75% area for process (25/75 split), or with 50% area for reactivation and 50% for process (50/50split). Generally, the 25/75 split is used for industrial dehumidification, low dewpoint and compact desiccant cooling applications. The 50/50 split is more often used for commercial cooling applications, or application where low temperature waste heat is available for reactivation. NovelAire also designs cassettes incorporating non- standard "split" arrangements, as well as "purge" arrangements for a variety of applications. Contact the factory for more information on non standard "split" configurations.

### Heat Sources

NovelAire desiccant wheels may be reactivated using electric resistance, (indirect) steam, (indirect) hot water, direct (or indirect) fired natural gas (or propane) heaters. Additionally, (indirect) solar or (indirect) waste heat may be utilized. **In all cases, desiccant wheel face temperatures, from either operating or radiant heat, may not exceed 350 Degrees Fahrenheit. All heaters must be equipped with suitable safety devices and controls to prevent exceeding this temperature limitation. Reactivation flow and wheel rotation must be maintained at all times the heater is in operation. Additionally, Direct Fired Natural Gas and Propane reactivation heaters should be designed to prevent flame or burning ember ingress to the desiccant wheel. Contact the factory for additional information regarding the use of direct fired reactivation heaters**

**and for interlock/control requirements.** Desiccant systems should be designed to allow for a two (2) minute minimum reactivation fan "purge" of the reactivation heater assembly (upon shutdown of the unit) to minimize shutdown peak wheel face temperatures. Additionally, OSHA and other applicable guidelines regarding surface temperature limitations (for personnel spaces) should be observed when designing reactivation ducts and when locating insulation on the desiccant wheel cassette.

# Wheel Performance

## Moisture Removal

Moisture removal varies for different reactivation configurations, reactivation energy, process entering conditions and wheel rotational speed. The following graphs detail moisture removal and process outlet performance for various process inlet conditions, based on fixed wheel speed and fixed reactivation temperature. For additional performance calculation, NovelAire offers a Windows Compatible Dehumidification Wheel Performance software package which can be downloaded from www@URL = www.novelaire.com. Contact the factory for the availability of this software. Moisture removal also differs for the type of wheel selected. See "Wheel Types" for more information. To select a wheel, first determine process face velocity and pressure drop. Use the desired process air volume (ACFM) and process face area (See "Wheel Dimensions, Face Areas and Weights") in the following Formula:

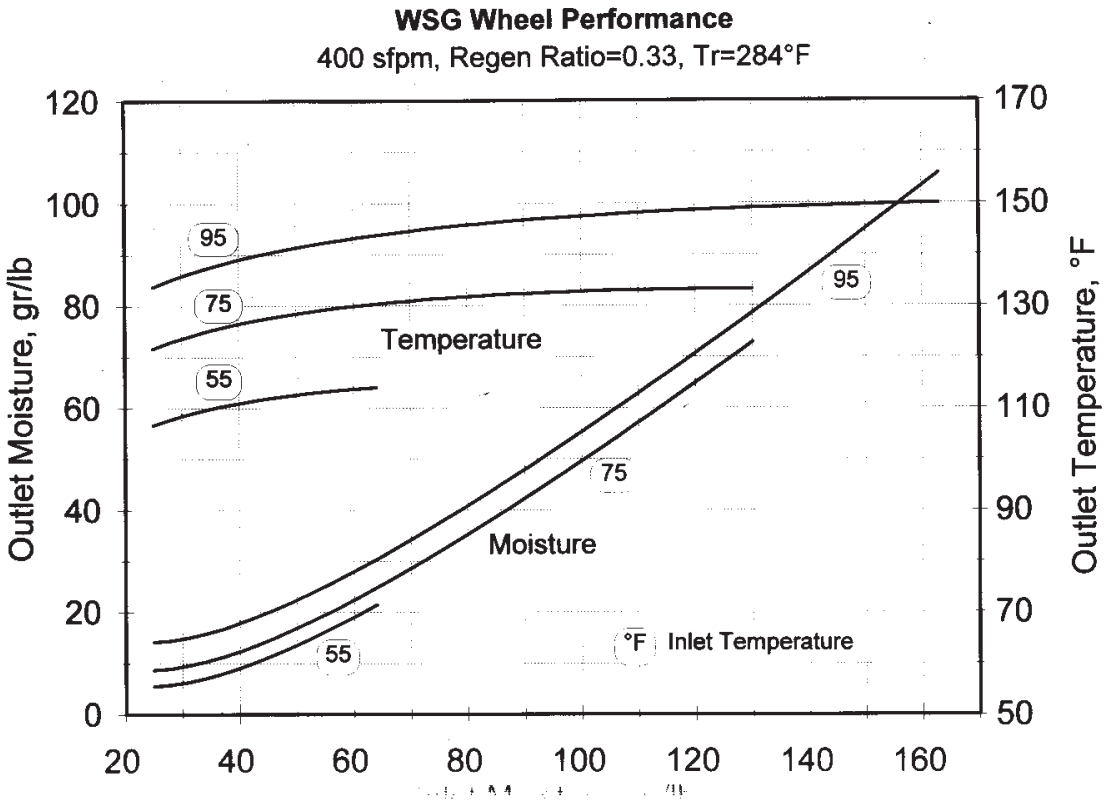
$$\text{Face Velocity} = \frac{\text{Design Process Flow Rate (ACFM)}}{\text{Wheel Face Area (Process Section)}}$$

Pressure drop is determined from the face velocity and the Pressure Drop Curve. Next, using the Performance Graphs, find the correct process "Inlet Moisture" on the appropriate performance graph, and plot vertically upward to the curves (lower set) representing inlet temperature. At this intersection point, read horizontally out to the scale marked "Outlet Moisture." This is the grains per pound of moisture in the process air stream after passing through the desiccant wheel. Again, using the correct process inlet moisture, plot vertically upward to the curves (higher set) representing inlet temperature. From the intersection, read horizontally outward to the scale marked "Outlet Temperature." This is the process outlet temperature after passing through the desiccant wheel. Next, calculate the following parameters:

$$\text{Reactivation Outlet Temp (FDB)} = \text{Reactivation Heated Temp (FDB)} - \left( \frac{\text{Process Outlet Temp (FDB)} - \text{Process Inlet Temp (FDB)}}{\text{Reactivation Air Ratio}} \right)$$

$$\text{Reactivation Leaving Moisture (gr)} = \text{Reactivation Entering Moisture (gr)} + \left( \frac{\text{Process Inlet Moisture (gr)} - \text{Process Outlet Moisture (gr)}}{\text{Reactivation Air Ratio}} \right)$$

***Please note that Reactivation Air Ratio is the Reactivation Air Volume (SCFM) divided by the Process Air Volume (SCFM)***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Outlet Moisture, gr/lb
Outlet Temperature, °F
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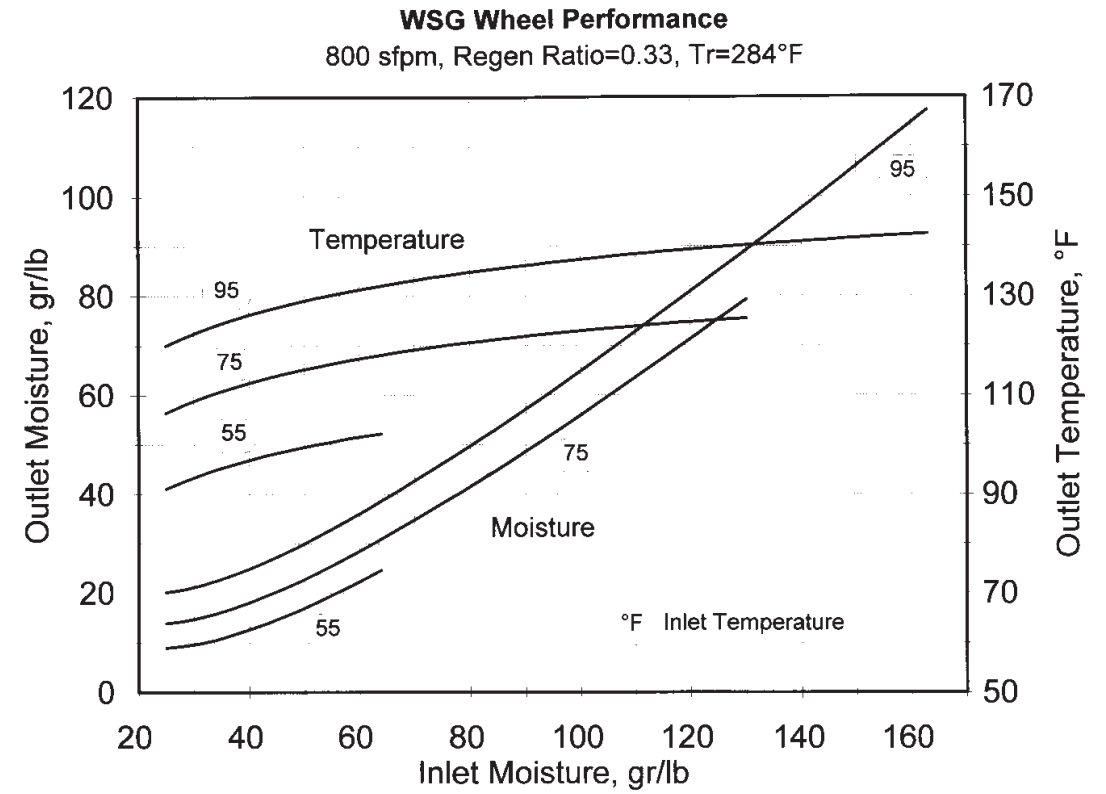
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Outlet Temperature, °F
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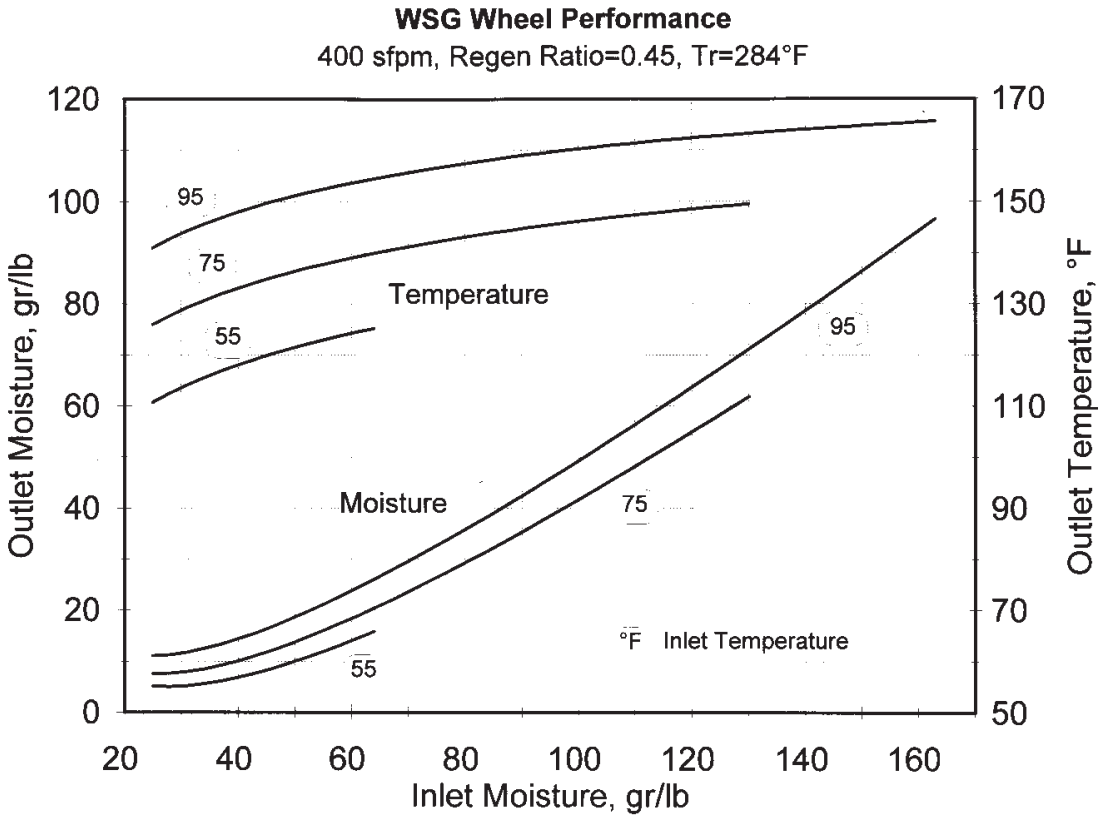
Inlet Moisture, gr/lb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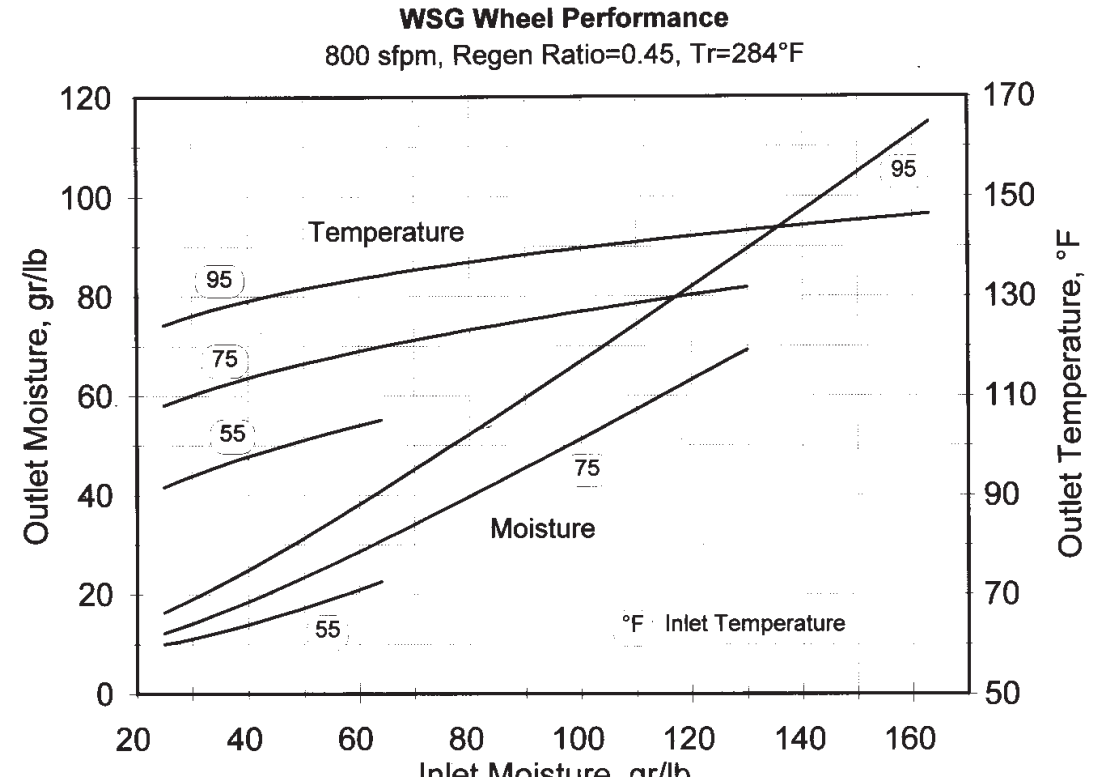
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Outlet Moisture, gr/lb
Outlet Temperature, °F
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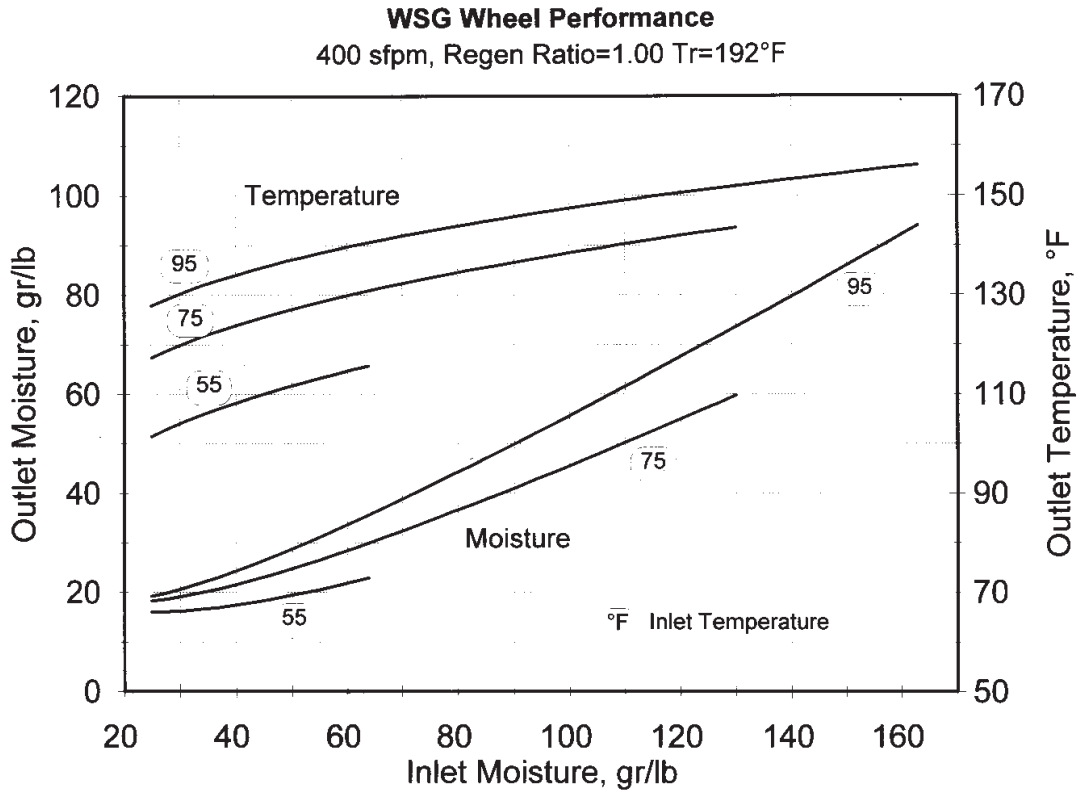
WSG Wheel Performance
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Outlet Moisture, gr/lb
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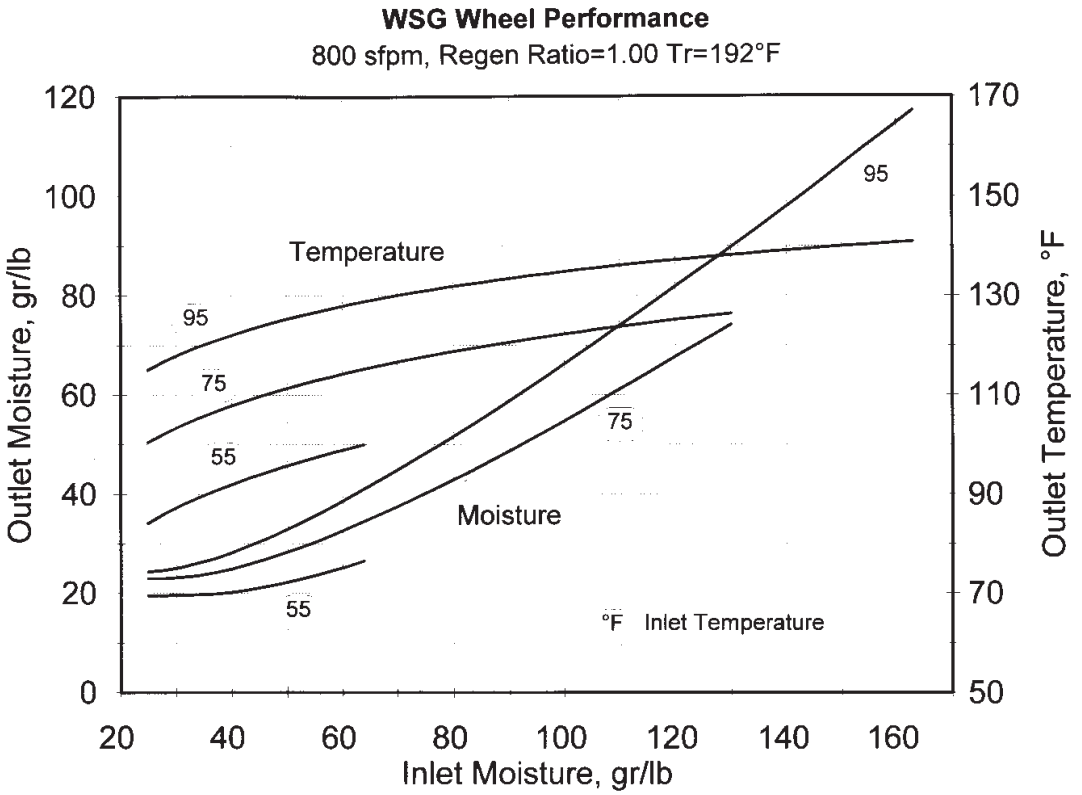
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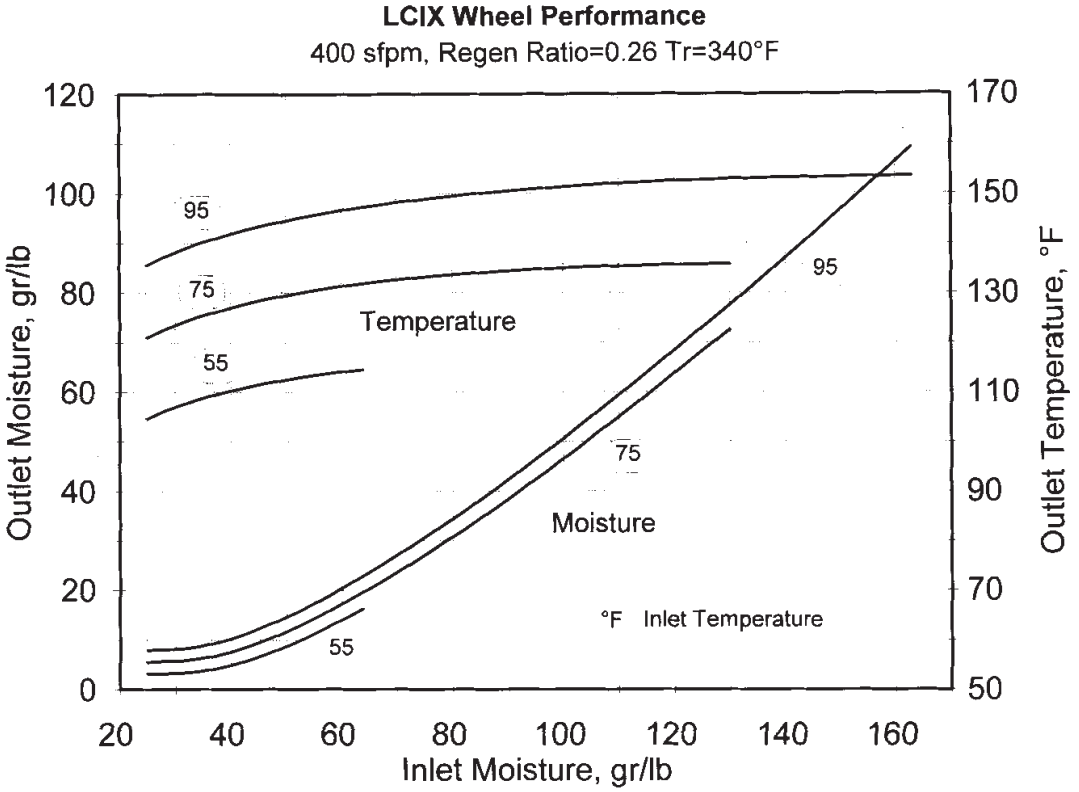
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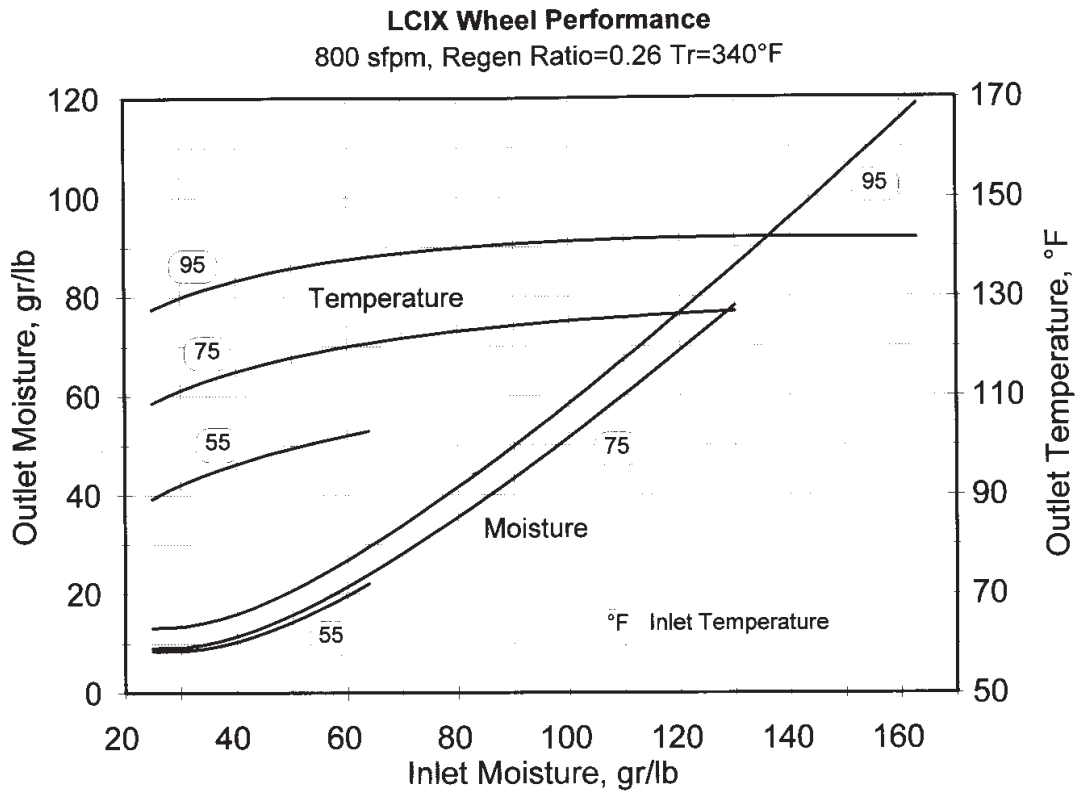
LCIX Wheel Performance
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Outlet Moisture, gr/lb
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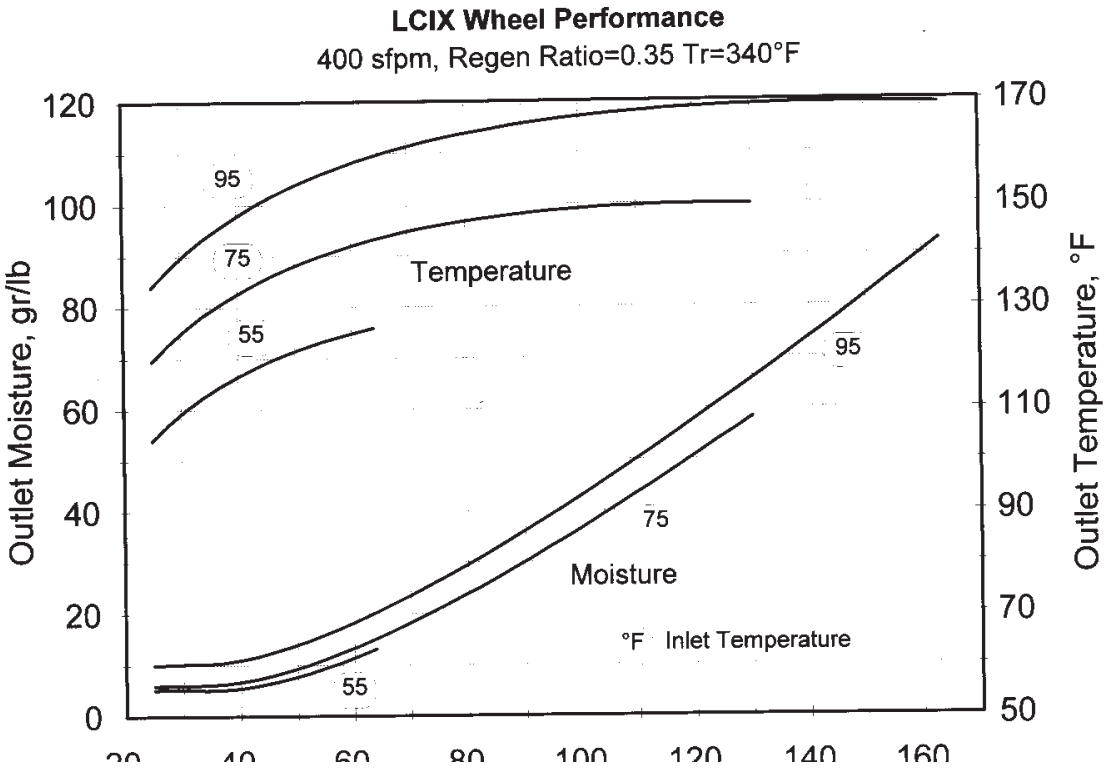
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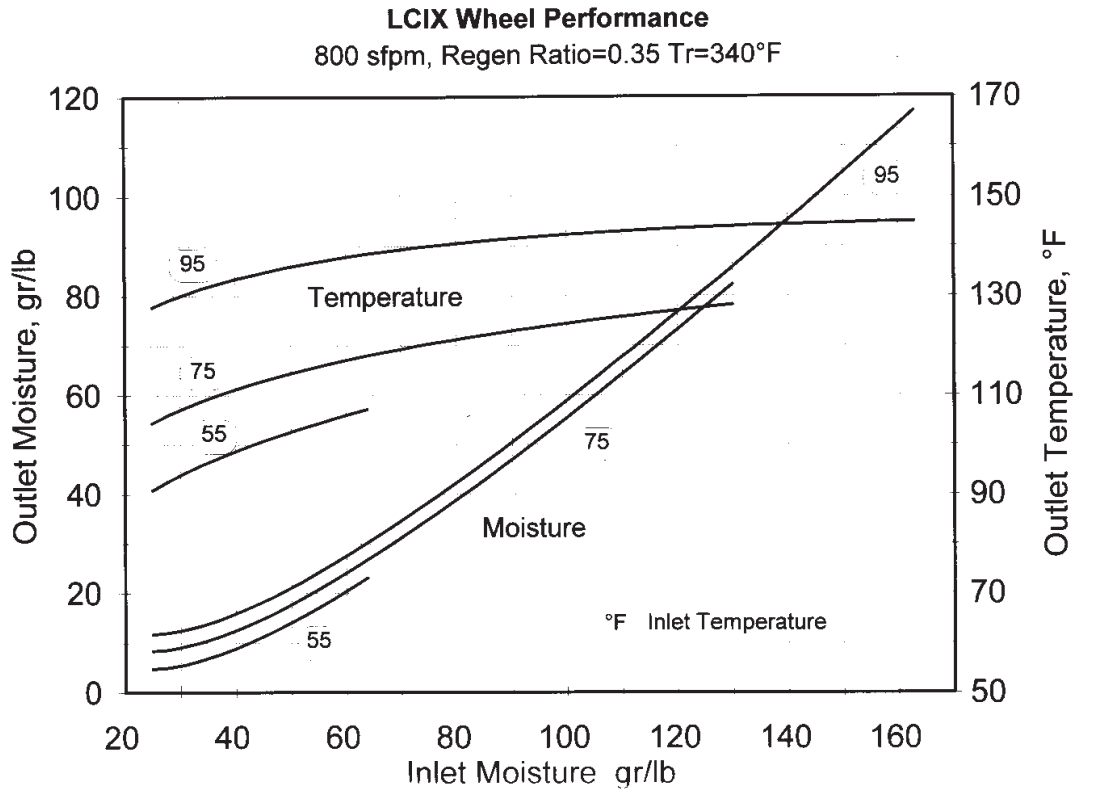
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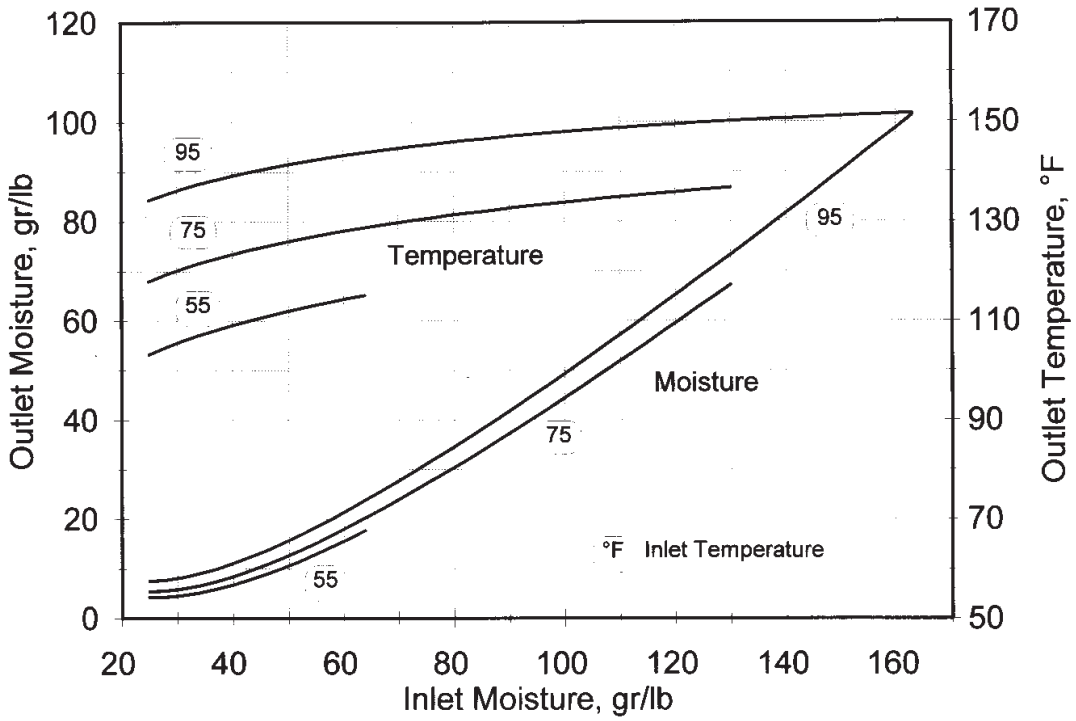
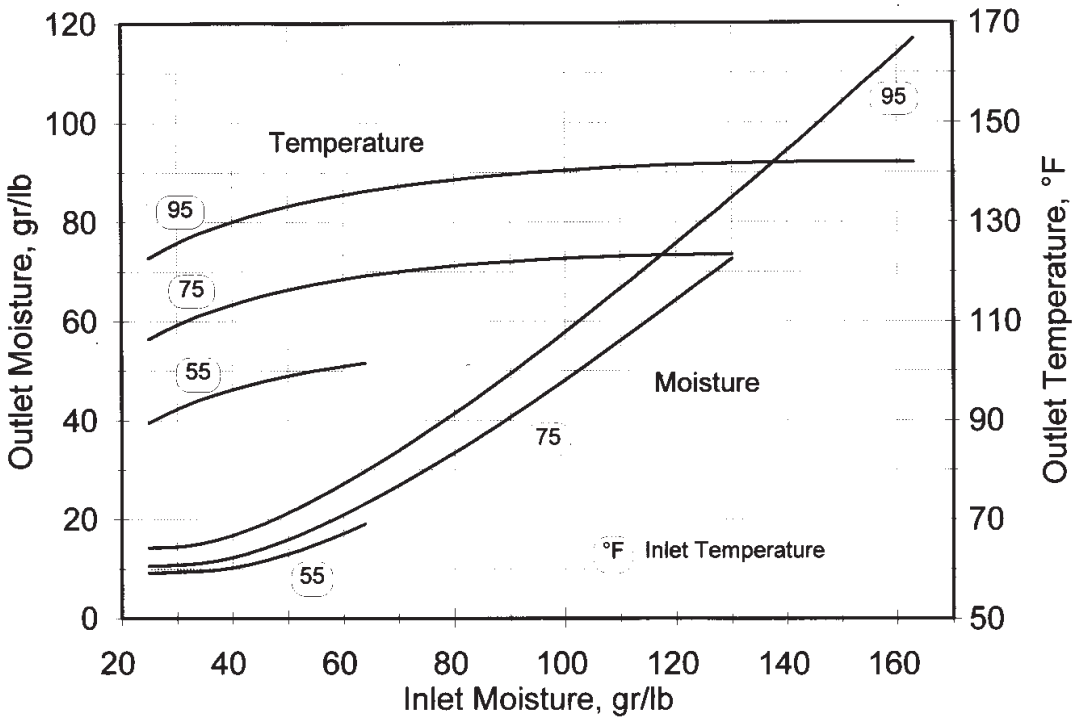
**LT3 Wheel Performance**

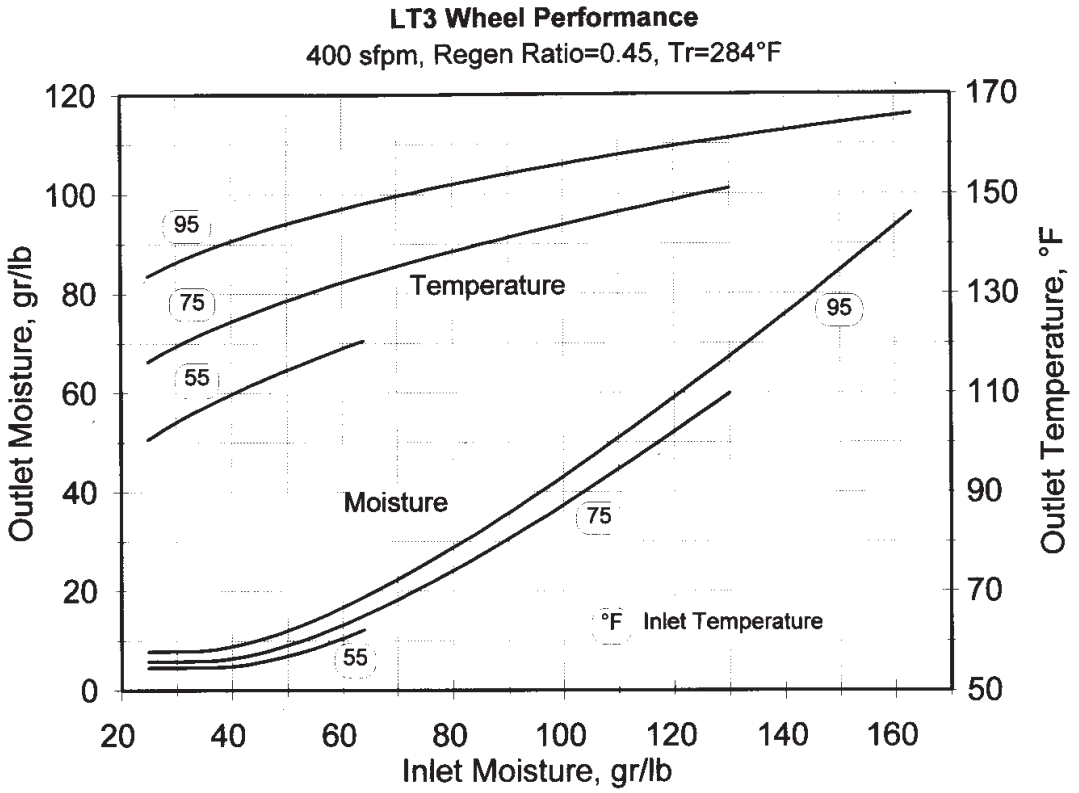
400 sfpm, Regen Ratio=0.33, Tr=284°F




**LT3 Wheel Performance**

800 sfpm, Regen Ratio=0.33, Tr=284°F

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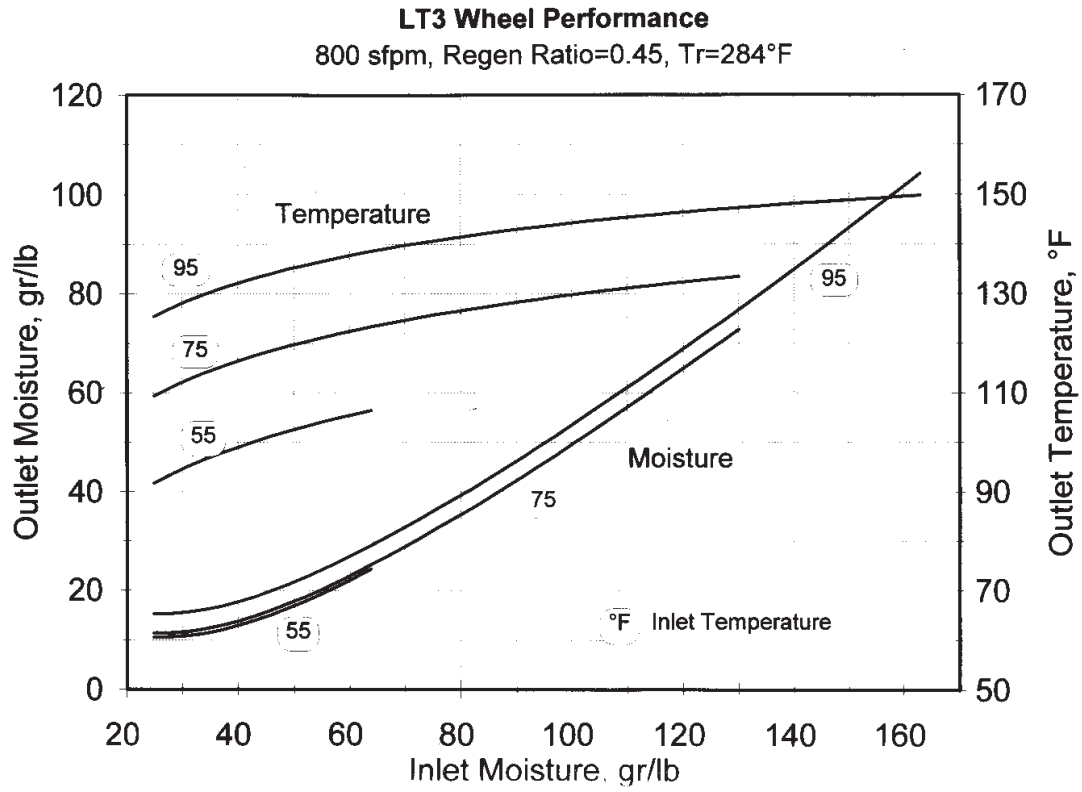
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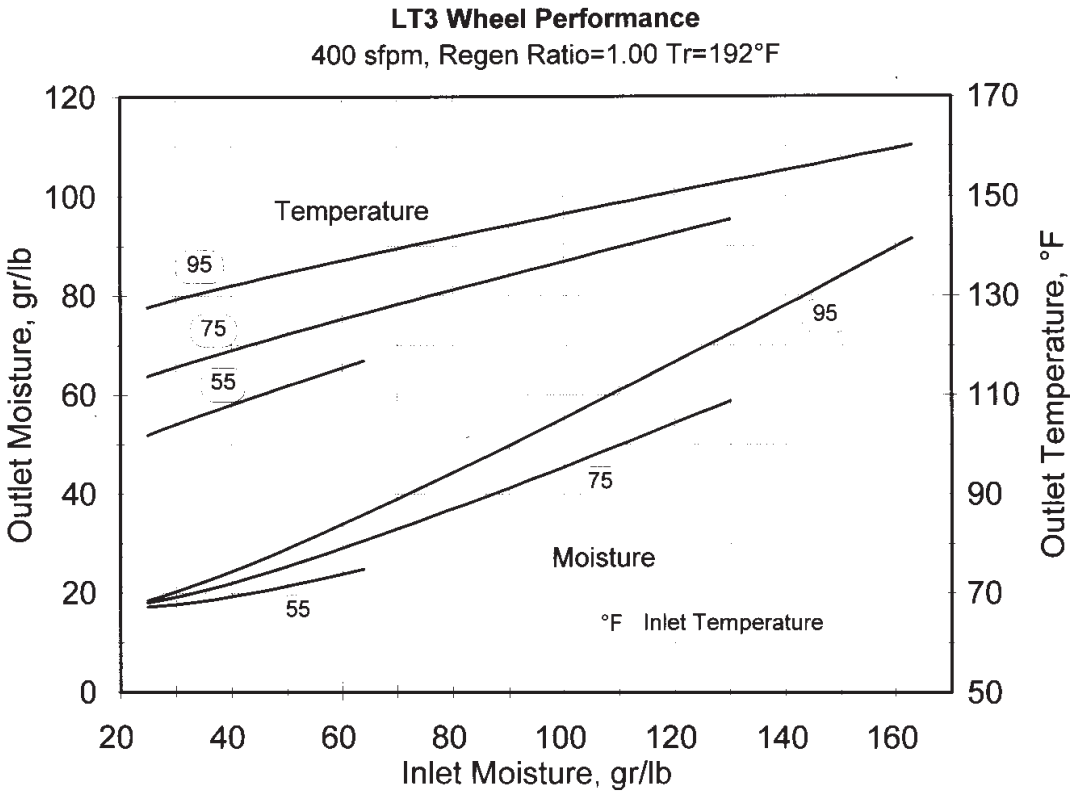
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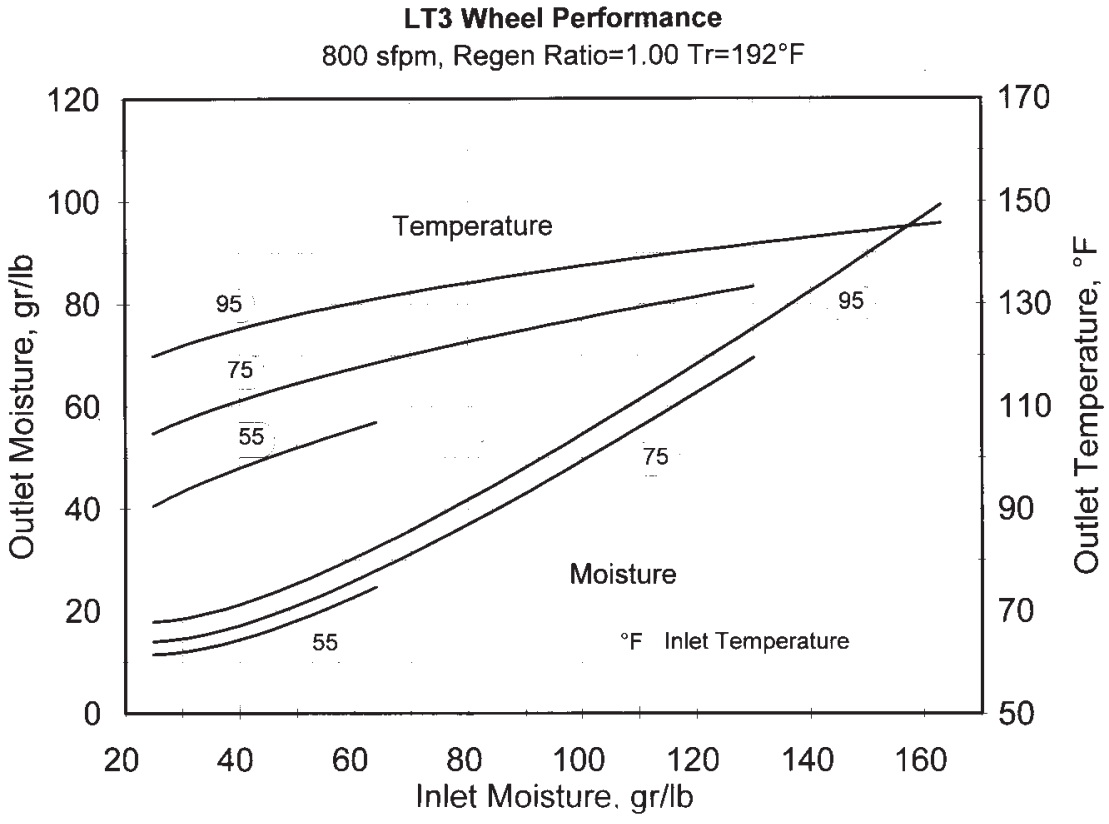
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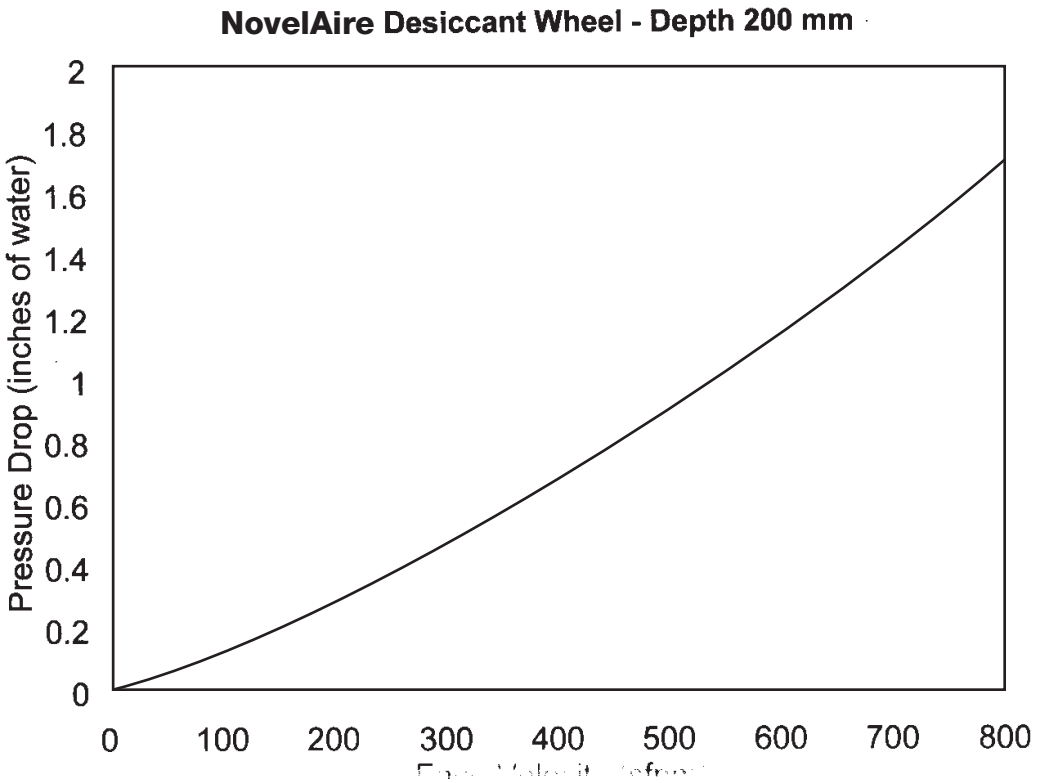


# Wheel Dimensions, Face Areas & Weights

## Wheel Diameter

NovelAire desiccant wheel diameter dimensions describe the outside diameter of the circumference of the main body of the desiccant wheel band. This is used to determine drive motor speed and drive system pulley or sprocket pitch diameters. On wheels greater than 550 mm diameter, face flanges (which exceed the diameter of the wheel) are used to provide for sealing surface as well as outer band structural rigidity. Consult the factory for detailed drawings, flange options and dimensional tolerances.

## Wheel Depths

NovelAire desiccant wheels are offered in a standard depth of 200 mm. Optional 50mm, 100 mm, 150 mm and 400 mm depths are offered on a non standard basis. Consult the factory for depth options and dimensional tolerances.

### Wheel Dimensions, Face Areas and Weights

| Standard 75/25 Configurations | | | | | Commercial 50/50 Configurations | |
|---|---|---|---|---|---|---|
| Wheel Outside Diameter(mm) | Wheel Depth (mm) | Wheel Weight (lbs.) | Process Area (sq. ft) | Reactivation Area (sq. ft) | Process Area (sq. ft) | Reactivation Area (sq. ft) |
| 250 | 200 | 45 | 0.295 | 0.098 | 0.196 | 0.196 |
| 370 | 200 | 80 | 0.716 | 0.239 | 0.477 | 0.477 |
| 440 | 200 | 100 | 1.046 | 0.349 | 0.697 | 0.697 |
| 550 | 200 | 150 | 1.499 | 0.499 | 0.999 | 0.999 |
| 770 | 200 | 200 | 3.200 | 1.067 | 2.134 | 2.134 |
| 965 | 200 | 350 | 5.221 | 1.740 | 3.481 | 3.481 |
| 1220 | 200 | 400 | 8.591 | 2.864 | 5.728 | 5.728 |
| 1525 | 200 | 900 | 13.076 | 4.569 | 9.137 | 9.137 |
| 1940 | 200 | 1300 | 22.822 | 7.607 | 15.215 | 15.215 |
| 2190 | 200 | 1500 | 28.946 | 9.649 | 19.297 | 19.297 |

# Wheel Maintenance

### Routine Maintenance

NovelAire desiccant wheels are designed for minimal maintenance over their operating lifetime. On an annual basis, the faces of the wheel should be checked to ensure no apparent dirt or debris, or damage to wheel faces from loose matter within the consumer's air handling unit. If desiccant wheels are used with proper filtration, the corrugated flow channels will have a minimum of dirt and dust buildup. This can be measured by the installation of a differential pressure detector measuring pressure drop across the wheel. If wheel pressure drop (for a carefully measured flowrate through the wheel) exceeds the design pressure drop by 10%, then the wheel should be cleaned. See "Cleaning the Wheel" for a detailed description. Pressure drop should be checked each time air handler filters are changed. One additional maintenance item would be to recoat the face flanges of the wheel with NovelAire's formulation of graphite lubricant. This should be done at normal intervals, coincident with seal replacement. NovelAire also generally recommends this (relubrication) procedure a minimum of every 16,000 hours of operation to extend seal life. Contact the factory for lubricant part number and application procedure.

### Cleaning the Wheel

In the event that routine annual inspection (or pressure drop greater than 10% of factory rating is observed) indicates that there is dirt or dust buildup within the wheel, then wheel cleaning is required as follows: Using 20 psig clean dry air, and a small air nozzle, blow air through one (1) face of the wheel. At a similar location on the opposite side of the wheel, gently apply a shop vacuum to "receive" debris exiting the wheel. Slowly work around the entire face of the wheel to complete the procedure. In the event that this method does not remove visual buildup or return pressure drop to within normal parameters, contact the factory for a wheel washing procedure. Do not use solvents or any other cleaning fluids on the face of the wheel. Additionally, although the desiccant wheel may be washed in a clean water solution, special precautions are required to ensure adequate drying of the wheel to prevent damage to sensitive internal surfaces.

## Lifecycle Testing

The desiccants impregnated in NovelAire's desiccant wheels are highly stable silicates and/ or alumina silicates. However, exposure to certain chemicals can result in a decrease in wheel performance. Silica gel wheels are subject to pore contamination from any sodium salts and most chlorides. Also, strong alkaline solutions will reduce the effective pore surface area of the silica. Molecular sieve wheels will be damaged by strong acidic solutions. All types of wheels will suffer from contamination when exposed to oil mists and irreversible dissolution of the desiccants will occur when exposed to strong reducing agents (e.g. Hydrazine). If a consumer suspects that a NovelAire wheel has be damaged during operation, or cannot otherwise trouble shoot poor performance of the wheel, then NovelAire may perform a lifecycle test on the wheel. Upon request, NovelAire will provide a small sample kit, enabling the customer to remove a small sample of the wheel material. This material is to be returned to NovelAire for detailed chemical analysis. These tests may confirm damage to the desiccant, indicate the end of useful life, or otherwise provide data necessary to determine additional actions. There may be a small fee for this service. Contact NovelAire for details on this procedure and sample kit part number.

NOVEL AIRE TECHNOLOGIES

HEAT & MASS TRANSFER PRODUCTS

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