PROVIDING THE BEST COMBUSTION SOLUTIONS AND EQUIPMENT IN THE WORLD
EXCELLENCE IN TILTING AND FIXED TANGENTIAL FIRING

YAW-Able Air Tips

Gas Compartments

Coal Compartments

Oil Compartments
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R-V Industries, Inc. is a world leader in providing high quality combustion systems from the pulverizer through the burner for nearly 40 years. R-V has designed and manufactured equipment for hundreds of units worldwide. We have completed projects for many types of fuels (coal, oil, natural gas and biomass) and firing system arrangements (tangential and wall-fired), including low NOx retrofits and the addition of or conversion to other fuels.

The R-V team has the technical knowledge and manufacturing capability to support all your combustion system needs. Our mission is to provide our clients with the best combustion system designs, engineered solutions and equipment in the world. A long and growing list of clients define R-V as a preferred supplier for equipment and technical support.

**CONSULTATION SERVICES**

R-V offers pre-outage and outage diagnostic support, fuel switch analysis, system design, installation support, start-up and optimization. Our engineers are qualified for all types of firing systems.
R-V engineers and manufactures our firing system equipment in our company headquarters in southeastern Pennsylvania. All firing systems are designed with the latest materials and components for long-term reliability.

- Power plant design engineers
- Complete boiler house engineering
- Controls engineering
- Metallurgical and manufacturing engineers
- Software capabilities
  - Solidworks
  - AutoCAD
  - Finite element analysis
  - CFD modeling
- Project management
- Combustion engineering and consultation

IN-HOUSE MANUFACTURING

R-V’s manufacturing team has decades of experience fabricating power plant equipment.

- ASME certified welders and weld procedures
- Certified weld inspectors
- Nuclear Quality Assurance (NQA-1) certification
- Safety and Health Achievement Recognition Program (S.H.A.R.P.) award winner presented by OSHA
NOZZLE DISTORTION IS A CHRONIC INDUSTRY PROBLEM

R-V’s Thermal Guard™ nozzle tips have become the dominant design in the industry for service longevity.

**Typical OEM Design:** tilting the nozzle tip exposes the outer plate to extreme temperature differential between the inside and outside of the plate, causing thermal distortion.

**Thermal Guard™ Series I:** design directs a high velocity stream of air over exposed surfaces, increasing radiation protection as tips are tilted, reducing the temperature gradient across plates.

**Thermal Guard™ Series II:** patented design provides additional radiation protection. As tips are tilted, the ported film cooling feature further reduces the temperature gradient across the exposed plate and helps reduce slag deposition. It is particularly suited for the more severe duty of upper burner levels.

**THERMAL GUARD™ SHOP COMPARISON TESTING**

To prove the effectiveness of the Thermal Guard™ nozzle tip designs compared to the OEM, thermocouples were installed on the inside and outside of the top plate to measure the temperature gradients.

![Graph showing temperature differential](image)

**Test Conditions**
- Nozzle Tilt: 15 Deg.
- Air Temp: 80°F
- Windbox Pressure: 2.0 in. wg.
- Equal Heat Input
**THERMAL GUARD™ DESIGN FEATURES AND BENEFITS**

- Protective air barrier.
- Pivot pin design available for furnace side nozzle tip removal.
- Various erosion protection options.
- Contoured corners reduce coal layout.
- Stiffeners welded to both inner and outer annulus.
- Corner welds shielded from radiations.

In *Includes all Series I features plus:*

- Ported film cooling increases cooling effectiveness and reduces slag deposition.
- Minimizes thermal gradients across plate work exposed to furnace radiation. Suited for severe duty or extreme conditions.

**Thermal Guard™ Air Nozzle**

R-V has adapted the Thermal Guard™ design features to the top and bottom of thousands of air nozzle tips. For tilt and YAW designs, side protective barriers are included as shown on the right.
WEAR RESISTANT OPTIONS FOR BURNER NOZZLES

STATIONARY COAL NOZZLES

Our stationary coal nozzles are cast or fabricated to the highest quality standards. When compared to cast nozzles, our wear options provide superior long-term protection against coal flow erosion. All coal nozzles are specifically designed or validated to match coal characteristics and pulverizer primary air flow. Complete coal nozzle assemblies with coal nozzle tips and numerous support bracket designs are available and pre-assembled to reduce installation manhours.

Original Equipment - Cast
Cast from 65-45-12 grade ductile iron.

Ceramic-Lined
Fabricated steel shell with pre-engineered high alumina ceramic tile lining.

Ceramic and Refractory Lined
Fabricated steel shell with ceramic tile lining in the inlet and high alumina rammable refractory through the transition.

Chromium Carbide Lined
Chromium carbide weld overlay lining on a steel shell throughout the inlet, transition and sides of the discharge throat. Weld overlay is easily repairable.
COAL NOZZLE TIPS

R-V’s THermal Guard™ coal nozzle tips are available with optional features to increase nozzle longevity. The standard thickness of the splitter plates, inner shroud and outer shroud can be increased to customer specifications.

A variety of high chrome 52-62 Rockwell C-Hardness overlay options are used to protect the splitter plates and inner annulus. Custom overlay options are also available to provide the best protection based on customer wear experience and firing tilt angle.
Many tangential and wall fired systems, especially older low NOx retrofits, are oversized. Specifically, the nozzles, registers and dampers are commonly too large. The common symptoms are:

- Low windbox air pressure
- Low nozzle exit velocities resulting in poor fuel air mixing
- Air dampers are closed at all loads to maintain windbox pressure
- Loss of air distribution control between windboxes and burners
- Reduced nozzle tip and register service life
- Localized slagging and nozzle/register pluggage
- High CO levels
- Uneven furnace gas temperature and emission profiles

DAMPER VENTURI INSERTS

Installation of damper venturi resize tangential windbox dampers to:

- Restore windbox and furnace DP control over greater unit load range
- Operate in control range
- Reduce NOx and CO on overfire air based combustion systems
- Improve nozzle tip cooling and life
- Increase hot air and PA flow to exhauster mills, particularly RPS mills
- Better control of flame stability at low loads

VENTURI INSERTS PROVIDE BETTER AIR FLOW CONTROL ACROSS THE DAMPER OPENING RANGE
**NOZZLE TIP RESIZING**

R-V’s engineers evaluate and determine the appropriate nozzle tip free area requirements to resize the firing system. The ideal time for resizing is with a major nozzle tip replacement. **Windbox computer modeling is used to resize nozzle tips.** Benefits include:

- Increased air velocity and fuel/air mixing
- Cooler running nozzle tips for longer service life
- Reduced number of tips and styles simplifying tilt linkage and maintenance
- Complements damper venturi inserts

- Improved windbox pressure control across load range
- Improved air flow control and reduced emissions
- Better control of flame stability at low loads
CONVERTING TO NATURAL GAS

While the natural gas supplies increase and clean air restrictions become more stringent, an increasing number of plants are converting or adding natural gas firing. Benefits include:

- Reduced fuel cost
- Emission reduction
- Reduced maintenance cost
- Easily adapted to existing units

R-V will design and manufacture the new natural gas firing system for your unit. In addition, we can package the scanners, side ignitors, valve train and control modifications required for your new gas firing system.
COAL SWITCHING

Contemplating switching to a different type of coal? Give us a call. Our firing system experts can explain the ramifications of switching coal types and recommend the best system solutions for any type of coal.

SOLUTIONS FOR HIGH SULFUR COAL FIRING

Boilers that fire high sulfur coal, regardless of the firing system, are more prone to burner slagging, pluggage and windbox fires. Have you experienced some of the problems listed below?

- Burner pluggage, overheating and nozzle distortion
- Coal nozzle and windbox fires
- Tilt problems
- Poor emission control
- High maintenance costs
- Increased LOI

SENSITIVITY TO PLUGGAGE

HIGH TEMPERATURE ADHESIVENESS FACTORS

BITUMINOUS (LOW S)

BITUMINOUS (MEDIUM S)

BITUMINOUS (HIGH S)

LIGNITE SUB BIT. - PRB

TYPICAL NOZZLE DAMAGE SEEN WHEN FIRING HIGH SULFUR COALS
WINDBOX UPGRADES

GRAPHITE DAMPER BEARINGS

R-V’s self-aligning graphite damper bearing upgrade restores dependable air flow and emission control by replacing the original rigid windbox bearings.

- Self-aligning graphite damper bearings compensate for damper misalignment and any windbox thermal distortion
- Available as a modular retrofit kit to simplify installation
- Allows damper drives to be set further from the hot windbox
- Available for parallel or opposed damper blade arrangements
- New stainless steel shafts are properly extended, when required, to reduce damper positioner overheating

TILT MECHANISM UPGRADE

Reliable nozzle tilts assure long term emission and efficiency control. At the heart of the R-V design are stainless steel bushings and graphite bearings. Each tilt upgrade is available in a modular kit form. Components are shop assembled and aligned assuring a smooth, accurate field installation. Each upgrade includes all necessary components, installation instructions and drawings for a successful system overhaul.
WALL FIRED BURNER AND OVERFIRE AIR REGISTERS

R-V offers replacement registers for aging low NOₓ wall fired burners and overfire air ports. Registers are rigorously shop tested for swirl and air flow reliability. The registers feature:

- A dual air zone providing low NOₓ capability with independent air flow and swirl control
- Inner and outer axial swirlers provide a wide range of swirl and flame shape control
- Minimal moving parts assure long term reliability and low maintenance costs
- Compatibility with most existing coal nozzles, igniters and scanners
- Designed for high temperature environments
- Performance predictions included
EQUIPMENT AND REPLACEMENT PARTS

R-V provides a variety of components for the pulverizer which are listed below:

- Bowl Extension Rings
- Clamping Rings
- Cones and Classifiers
- Convertor Heads, Covers and Vanes
- Journal Shafts
- Main Vertical Shafts
- Mill Bodies and Parts
- Pyrite Access Door
- Upper Mill Body Access Door
- Upper and Lower Journal Housings
- Vane Wheels and Deflectors
- Whizzer Wheel Assemblies

PULVERIZER ACCESS DOORS

R-V’s larger access door is designed to replace smaller existing doors by providing:

- Access to inside of the mill without the need to remove the journal
- Inspect and complete minor repairs on the bowl, journal and vane wheel
- Hinge design meets NFPA pressure requirements
- Custom engineered sizes available

PYRITE ACCESS DOORS

R-V’s pyrite access door is a barn-style double-hinged design. It provides access to the pyrite area of the mill for scraper and main shaft seal inspection and repair.
VANE WHEELS AND DEFLECTOR REPOSITIONING

R-V furnishes vane wheel and deflector packages. If your existing vane wheel is not worn, we furnish the deflector only. A unique aspect of the R-V solution is that we position the vane wheel deflector out of the erosion zone resulting in:

- Coal and air mixing occurs above the deflector meaning greatly reduced deflector wear
- Horizontal air vector is at the top of the bowl giving improved spillage control
- Can reuse the existing vane wheel by replacing only the worn deflector
- Air velocity and pressure drop are maintained preserving mill performance

OEM VANE WHEEL DESIGN PROBLEMS

- Deflectors are too high in the mill causing the coal/air mixture to blast the deflector, causing excessive wear
- Air turns inward too far above the bowl increasing the potential for spillage
- Deflector is interrupted by journal openings resulting in spillage and directing the coal/air mixture at the journal head causing increased wear

R-V LOW DEFLECTOR SOLUTION

- Full 360 degree coverage
- Significantly reduces wear by placing deflector under coal/air mixing point
- Air is directed inward at the top of the bowl improving spillage control
- Allows lower location of large access door for easier entry
- Significantly reduced equipment and installation costs compared to original equipment design
RIFFLE ELEMENT DESIGNS

With three riffle element design choices, R-V Industries provides the coal flow distribution control and quality you have come to rely on. Choose from the original equipment, mid-cut or coarse cut models. The mid and coarse cut designs are used to minimize system pressure drop and maximize primary air flow. Cast, fabricated and ceramic lined distributor housings are also available.

**Original Equipment**
- Made to original equipment specifications
- Smallest openings of the three designs

**Mid-Cut**
- Assembled design with mid-sized openings
- Thicker material but lightest overall weight
- Lowest cost design
- Reduced pressure loss
- Material options include carbon steel, AR400 and AR500

**Coarse Cut**
- Sectional design provides easier handling and allows replacement of worn sections
- Widest opening size of the three designs
- Material options include carbon steel, AR400 and AR500
ADJUSTABLE RIFFLE ASSEMBLY

Balanced coal and primary air flow have shown to improve combustion in the furnace and help eliminate numerous related burner problems and emission concerns. R-V’s adjustable riffle assemblies allow you to redistribute coal flow online without restricting primary air flow. R-V assemblies offer:

- Complete housing replacement
- Modification kits for existing housings
- 2 or 3 way distribution applications
- The perfect compliment to online coal flow measurement systems

EPRI closed loop flow tests evaluated the R-V adjustable riffles’ ability to control coal and transport air flow under simulated plant conditions. The results showed that the adjustable riffle can redistribute coal flow from an 80% - 20% imbalance to a 50% - 50% balance without increasing pressure loss. Additionally, primary air distribution can also be controlled.
OBSERVATION AND ACCESS DOORS

DIRECT REPLACEMENTS AND CUSTOM SIZES

R-V offers a full line of furnace, pulverizer, duct and windbox doors including direct replacements for many OEM designs. All furnace doors are available with seal boxes and tube panels as an option. Styles are adaptable to any OEM boiler design.

Observation Doors
- 4” x 10” and 6” x 12”
- 5 1/2” diameter
- 3” and 6” diameter for pressurized furnaces

Access Doors
- 15” x 21” oval
- Water-cooled
- Non-insulated
- Mineral wool or refractory insulated
- Pulverizer and windbox access doors
- Custom doors available

5-1/2” ROUND OBSERVATION DOOR
4” X 10” OBSERVATION DOOR
15” X 21” OVAL ACCESS DOOR
HINGED ACCESS DOOR
OBSERVATION DOOR FOR PRESSURIZED FURNACE 3” AND 6” AVAILABLE
DRIP SCREENS

R-V flexible drip screens last longer than traditional rigid screens which are susceptible to warping. The benefits of a flexible drip screen include:

- Easy Installation: screens ship with attachment bar to easily bolt onto your mounting apparatus
- Reduced Maintenance: flexible design allows screens to be rolled up and secured with S-hooks
- Improved Durability: corrosion and heat resistant screens handle the ash hopper’s difficult conditions that cause other rigid screens to warp
- Design Feature: dual layer design is supplied with an open bottom
- Lighter Design: reduces stress on waterwall tubes

SEAL PLATES

All R-V furnace bottom seal plates are manufactured to original equipment specifications and are adaptable to any furnace design. Material options include, but are not limited to:

- 316L Stainless Steel
- Inconel 600
- Inconel 601
- Inconel 625
- AL6XN
- Carpenter 20
ASSEMBLIES FOR MANY FUEL TYPES

R-V designs and manufactures complete windbox assemblies for coal, oil, and gas-fired tangential furnaces. Our expertise includes both mechanical and performance design. New windboxes are fitted with the latest components for emission control and long term reliability.
SOFA Windboxes
Main Windboxes
Stationary Coal Nozzles
Gas Nozzle Tips
Air Nozzle Tips
Oil Nozzle Tips
Coal Nozzle Tips
Pilot Torch Nozzles
Diffusers
Tilt Mechanisms
Graphite Damper Bearings
Opposed Blade Upgrades
Complete Damper Frames
Oil Guns and Tips
Gun Retract Mechanisms
Access Doors
Observation Doors
Riffle Elements
Flexible Drip Screens
Seal Plates
Pulverizer Parts
Whizzer Wheel Assemblies
Mill Fire Detection System
Field Service Support
R-V INDUSTRIES, INC.
584 POPLAR ROAD
HONEY BROOK, PA 19344
WWW.RVII.COM
610.273.2457