

NORAM
SULFURIC ACID
Products and Services

NORAM GAS DUCTING



With more than 25 years experience in designing ducting for sulfuric acid retrofit projects, NORAM has designed hundreds of ducting systems in sulfuric acid service. NORAM has experience in the design of the ducting segments and splice bands location to account for imprecision in location estimates which helps construction contractors have a better field fit-up. NORAM offers low pressure drop and corrosion resistance ducting at lower cost for the sulfuric acid industry.

Scope of Work

Design, fabrication, and supply of:

- Complete ducting system for new plants
- Retrofit ducts when replacing equipment
- Replacement, repair and improvement of existing ducting systems

Materials of Construction

- **Carbon Steel (ASTM A516 Grade 70)**
 - For gas stream temperature 70 - 850°F
 - 1/4" - 3/8" thickness
 - Nominal 1/8" corrosion allowance
- **304L Stainless Steel**
 - For gas stream temperature <380°F
 - 1/8" – 1/4" thickness
 - No corrosion allowance required
- **304H Stainless Steel**
 - For gas stream temperature 700 - 1250°F
 - 1/8" – 3/8" thickness
 - No corrosion allowance required
 - High tensile yield strength
 - High carbon content gives the material greater heat resistant qualities
 - Greater short and long term creep strength
- **Refractory Lined Carbon Steel**
 - For gas stream temperature >1250°F
 - 3/8" or 1/2" thickness
 - No corrosion allowance required

Design Code and Standard

NORAM ducting follows the following design code and standards:

- ASME BPV VIII, div 1, B31.3
- EJMA

Features of NORAM Ducting

- Low pressure drop
- Corrosion resistance
- Safety allows for thermal expansion
- Manways and inspection ports for dampers/ equipment



Sulfuric Acid Plant Ducting

Design Principles

Process

- Minimize pressure drops in designing routing, transition shapes, elbow types with aid of computational fluid dynamics (CFD) analysis

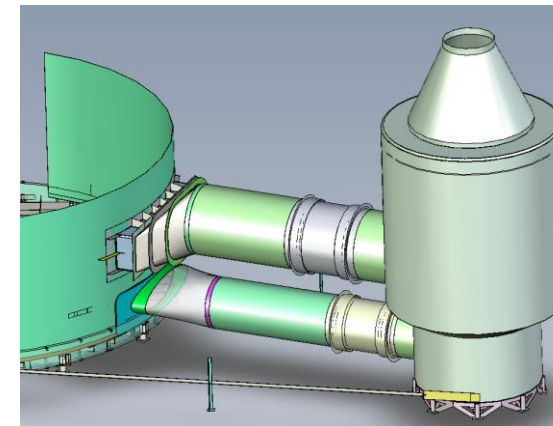
Mechanical

- Protect nozzle-to-vessel connections while maintaining the mechanical integrity
- Make best use of the mechanical strength of the connecting equipment and spring support
- Use thick wall single or double convolution expansion joints for their versatility to handle axial, lateral and rotational movements, as well as durability and ease to repair

Ducting Design

NORAM uses these strategies to achieve low pressure drop across ducting:

- Sizing duct diameter up to 9' or higher
- Designing using gradual turning elbows R/D equal to or less than 1
- Using "Y" instead of "T" for ducts connections
- Ensuring gradual entrance to use all of the nozzle cross sectional area for transitions to nozzles



Ducting Design: Nozzle Connections

- Designing ducting to accommodate thermal movement
- Using expansion joints to handle axial, lateral, and angular movement
- Minimizing number of expansion joints and tie-rods



Ducting Around a Converter

Design Tools

Various tools are used to analyze and optimize NORAM's ducting design, including:

- NORAM's proprietary Heat and Mass Balance
- 3D CAD software models for optimal layout
- Computational Fluid Dynamics (CFD)
- Finite Element Analysis (FEA)
- Caesar II

Expansion Joints

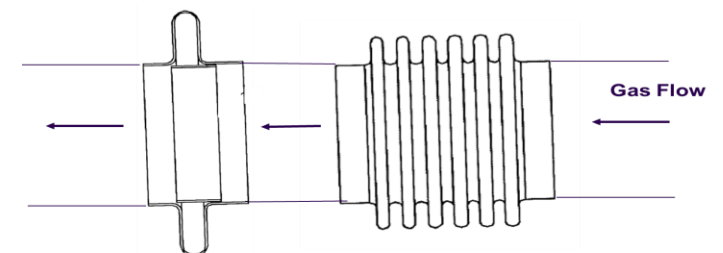
NORAM offers two designs for expansion joints:

1. Single Convolution

- Typically made out of 304 stainless steel
- 1/8" thickness
- Limited handle movement
- Easy to repair

2. Multiple Convolution

- Stainless steel or RA 253 material
- Thin walled, 1/16" – 1/32"
- More handle movement
- Difficult to repair due to thin walls



Single Convolution

Multiple Convolution



Expansion Joints

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NORAM'S TURBOSCRUBBER FOR GAS SCRUBBING
NORAM STAINLESS STEEL CATALYTIC CONVERTERS
NORAM RF™ RADIAL FLOW GAS-TO-GAS HEAT EXCHANGERS
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NORAM BRICK-LINED ACID TOWERS
NORAM SULFUR & SPENT ACID BURNERS
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NORAM ANODICALLY PROTECTED ACID COOLERS
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NORAM SX® TOWERS AND NORAM SX® PUMP TANKS

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NORAM ENTRAINMENT MITIGATION DEVICE (EMD)
NORAM ACID DILUTION SYSTEMS
NORAM SX® MATERIAL
NORAM SX® ACID DISTRIBUTORS
NORAM SX® PIPING
NORAM SX® VALVES
NORAM GAS DUCTING
NORAM DAMPER
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