

# **PMA Manufacturing Equipment**

## **Overview and Selection**

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ECF, INC.**

# Topics

- **Factors Affecting the Selection of Modifiers**
- **Typical Processes for Addition of Modifies**
- **Process Equipment Breakdown and Design Criteria**
- **General Equipment Discussion**



# Factors Affecting Selection of Modifiers

# Chemistry then Physics

- **Market and Competition Dictates Modifier**
- **Quantify Physical Properties of Both Asphalt and the Modifier**
- **Resources**
  - **In House Technical**
  - **Formulators**
  - **Vendors**

# Chemistry

## ● Asphalt Properties

- Chemical Makeup
- Consistency of Crude Slate from Supplier

## ● Polymer or Other Modifier Selection

- Formulator
- Vendor

## ● Best Method of Combination

- Mixing Temperatures
- High Shear vs. Low Shear
- Linking Agents or Other Additive Additions

# Physics

● Heat

● Agitation

● Shake and Bake

# Heat

## ● Process Temperatures

- Raw Materials Storage Temperatures

  - Base AC Storage Temperatures 280 - 320°F

  - Polymer Storage Temperatures <100°F

- Optimal Mixing Temperatures 360 - 400°F

- Finished Product Storage Temperatures 280 - 320°F

## ● Heat Generating Equipment

- Hot Oil Heaters

- Boilers

- Direct Fire Heaters

- Heat Exchangers

## ● Maintenance Heating Considerations

- Tracing and Insulation



# Agitation

- **Physical Characteristics of Polymer Determine Best Means of Handling and Agitation**

- **Shape**

- Bead, Pellet, Crumb, Block or Liquid

- **Density**

- Bulk Flow Characteristics

- **Melt Point**

- Dispersion Temperatures

- **Low Shear vs. High Shear**

- **Low Shear**

- Paddle and Blade Type Tanks Mixers
    - Re-Circulation Pumps

- **High Shear**

- Colloidal Mills
    - Homogenizers



# Design Considerations

- Flexibility

- Operability

- Safety

- Cost

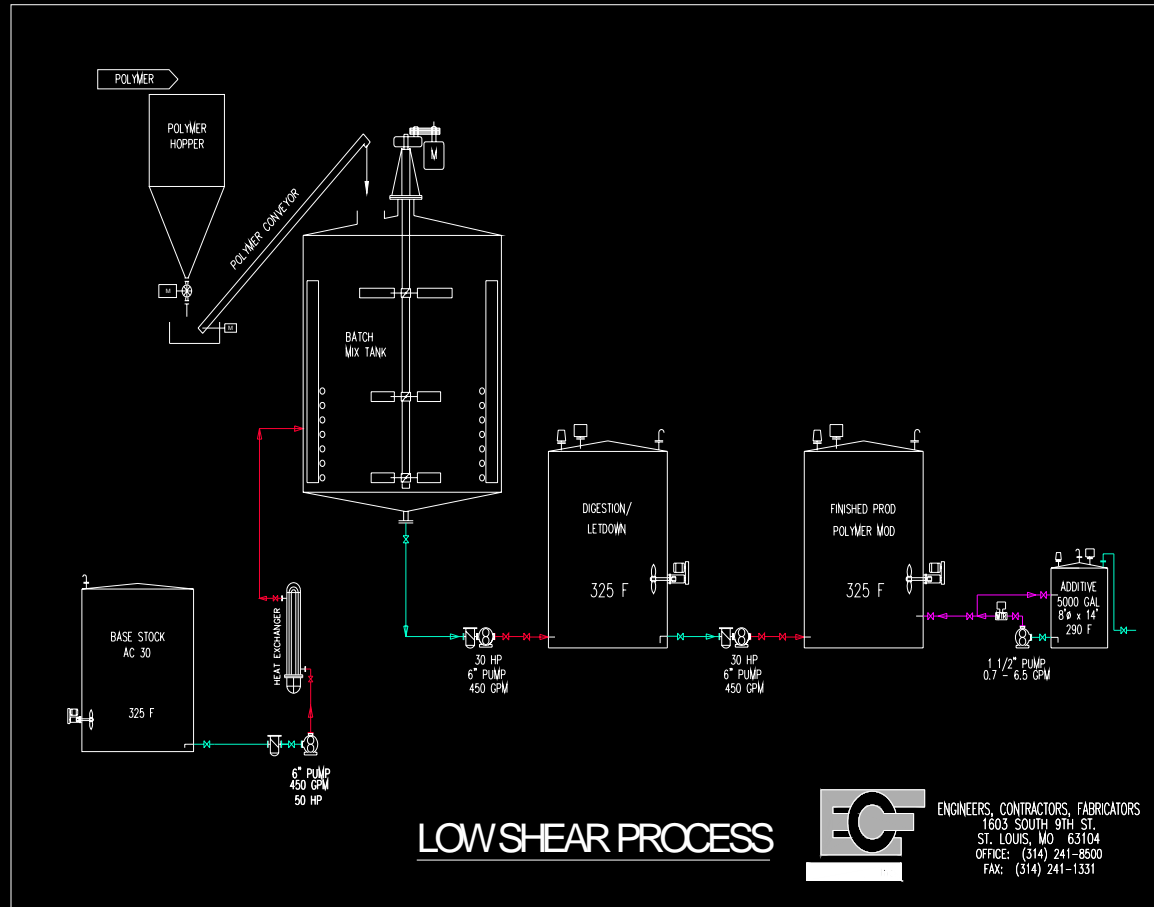
# Basic Processes



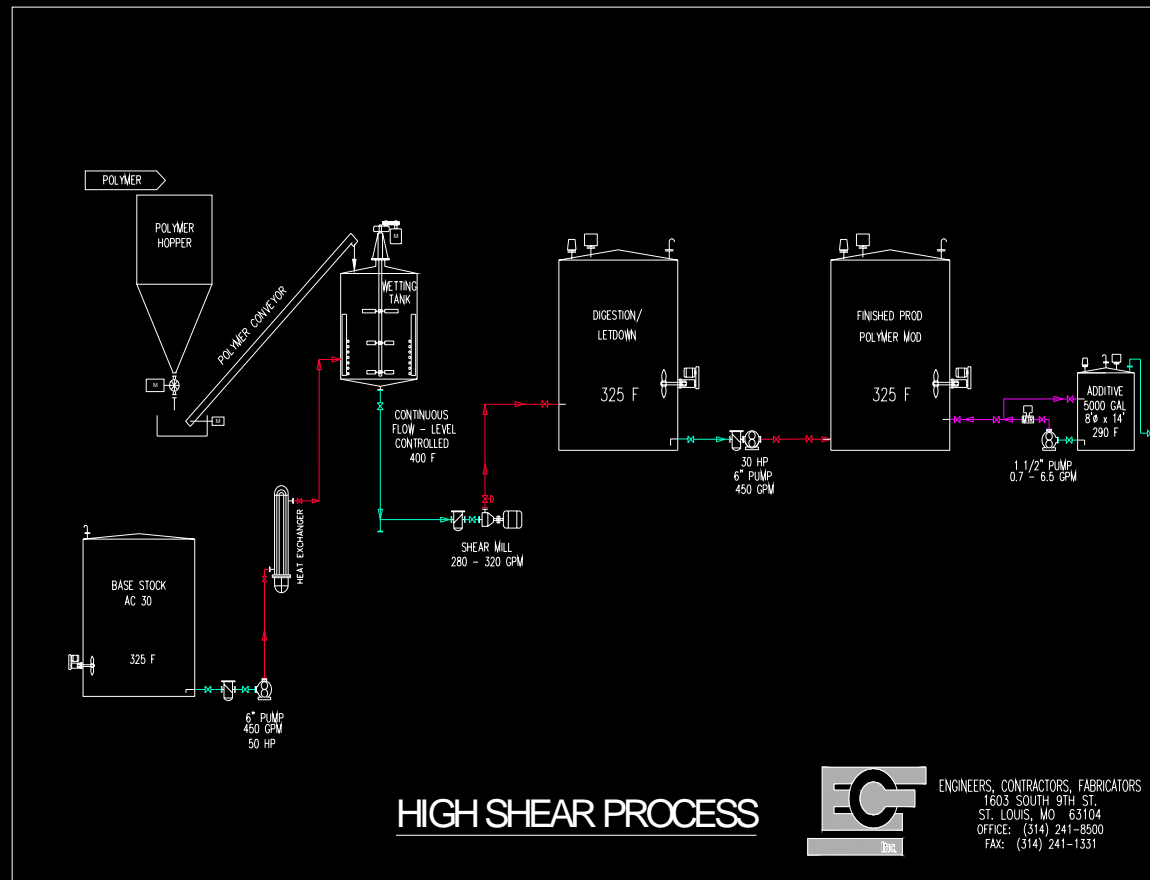
● Low Shear

● High Shear

# Low Shear Flow Diagram



# High Shear Flow Diagram



# Bulk Polymer Storage Considerations

- **Delivery Method**
  - Box, Bag, Block or Bulk
  - Liquid
  - Truck or Rail
- **Delivery Amounts**
  - Pallet Floor Plan
  - Single or Double Stack
- **Material Flow Considerations**
- **Climate Controlled? Indoor/Outdoor**
- **Exposure to Sunlight**
- **Local Fire Code Issue i.e. Sprinkler Systems**
- **Pallet, Cardboard and Bag Disposal**
- **Storage Space Usually Too Small!!!!!!**

# Bulk Transfer System Considerations

## ● Based on Type of Deliver Container

### ■ Box

#### ● Box Dumpers

- Pre-fabricated
- Fabricated on Site

### ■ Bags or Super Sacks

#### ● Hoist Delivery Systems

### ■ Block Systems

#### ● Air Systems and Conveyors



# Delivery Systems



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# Hopper Design Considerations

- **Batch or Production Run Size**
  - Back Into Dimensions by Weight
  - Polymer Density Varies
  - 27 to 35 Pounds/Cubic Ft
  - Usually Based on Number of Bags or Boxes
- **Clearance**
  - Material Handling Space Requirements
  - Headroom
  - Operator Safety and Production Requirements
  - Ease of Maintenance and Cleaning
  - Type of Delivery to Wetting or Mix Tank
- **To Insure Complete Delivery to Process Walls Have to Be Greater Than 45°**

# Polymer Hoppers



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# Conveyor Type and Selection

## ● Screw Conveyors

- Economical
- Easy to Maintain
- Can Plug

## ● Disk Conveyors

- Fits Into Tighter Spaces
- More Flexible Geometrics

## ● Pneumatic Conveyors

- Can Convey Longer Distances
- Reliable
- Loud
- Requires Star Gears and Cyclones



# Conveyors



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# Conveyors



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# Low Shear Mix Tank Process

- **Equipment**

- Large Scale Mix Tank

- **Purpose**

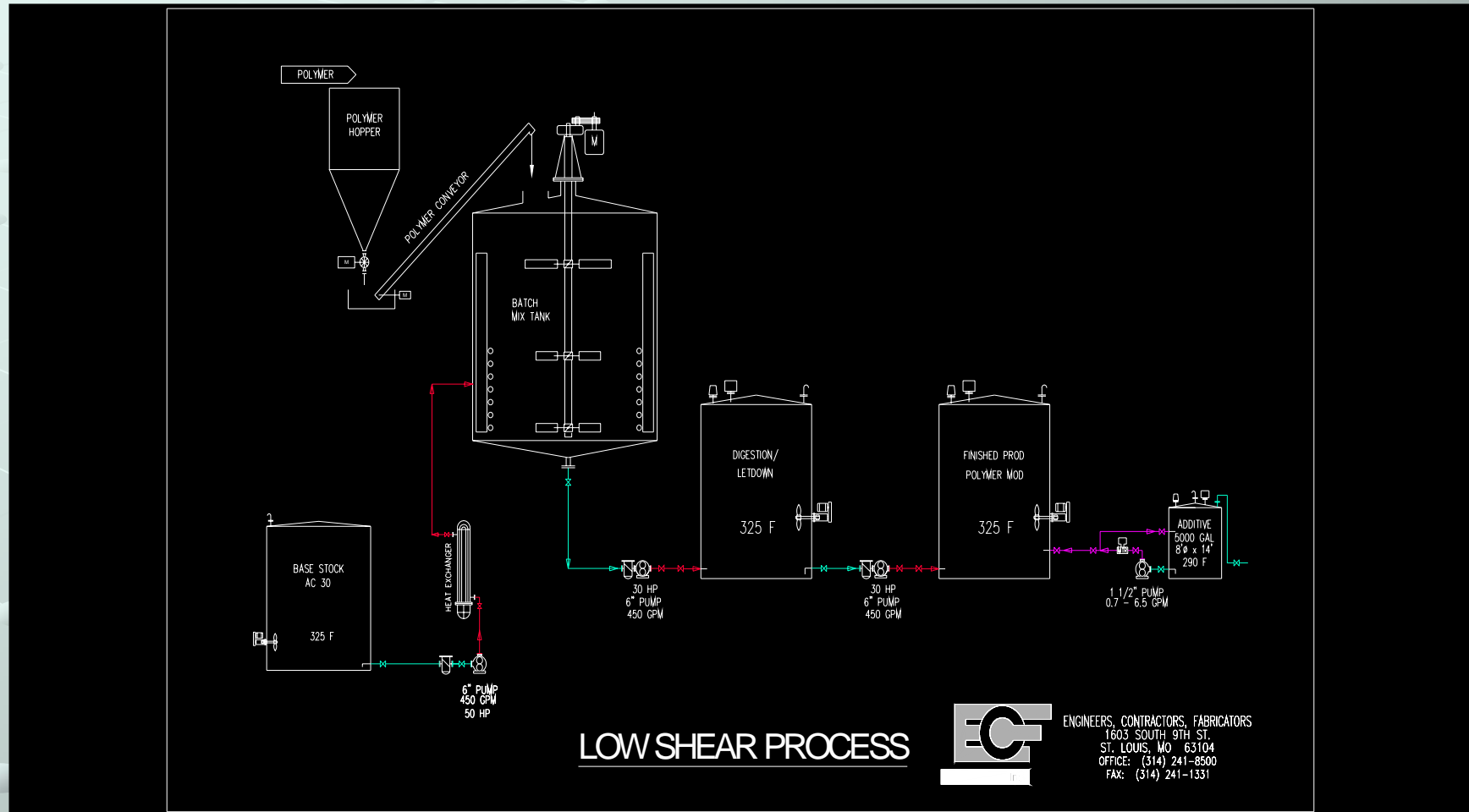
- Introduce Polymer in a Large Scale Batch Tank and Disperse Using Low RPM Mixer

- **Description**

- Normally Base AC is Pre-Heated to Mixing Temperature, Typically with a Day Tank or Heat Exchanger Then Pumped Into Mix Tank in a Pre-Determined Amount
  - Polymer is Introduced Into “Vortex” Created by Large In-Tank Mixer
  - Polymer is Drawn Into AC Down the Center Axis of the Tank and Flows Up the Sidewalls Insuring Consistent Dispersion
  - Polymer Concentrations are Variable But Usually Limited to a Maximum of 12%
  - Mixing Temperature Varies between 360 and 400°F
  - “Gentle” Mixing Until Polymer is Completely Dispersed



# Low Shear Flow Diagram



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# Low Shear Process Considerations

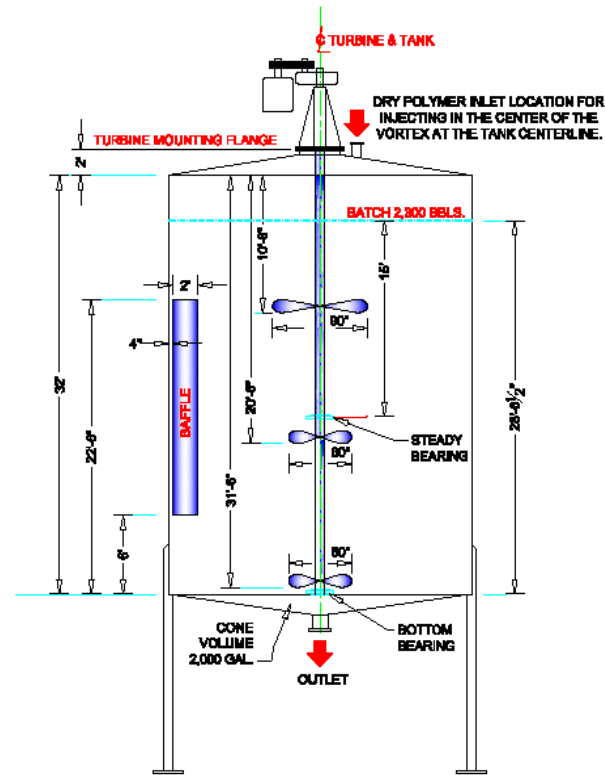
- **Up to 40,000 Gallon Batches**
  - Over 40,000 Gallons Mixing Becomes a Logistical Problem.
- **Batch Times are Chemistry Specific But Can Range From Six to 24 Hours**
- **Tank and Mixer Design Critical to Efficiency**
  - Height and Width Ratios are Very Important
  - Creating a Vortex for Dispersion is Critical
    - Baffle Design and Placement
    - Mixer Blade Design is Tank Specific
    - Rafting is a Potential Result if Design is Not Correct
- **Tank Heating Design and Placement**
  - External Heating Pads
  - Helical Coils
  - Floors Banks

# Mix Tanks



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# Mixer Design



## NOTE:

1. TOP OF UPPER BAFFLE IS 15' BELOW 80° TURBINE BLADE.
2. UPPER TURBINE BLADE IS SUBMERGED 47".
3. LOWER TURBINE BLADE IS SUBMERGED ± 30".

## POLYMER MIX TANK



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# Mixers



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# Typical High Shear Process

## ● Equipment

- Wetting Tank
- High Shear Mill or Homogenizer
- Digestion Tank

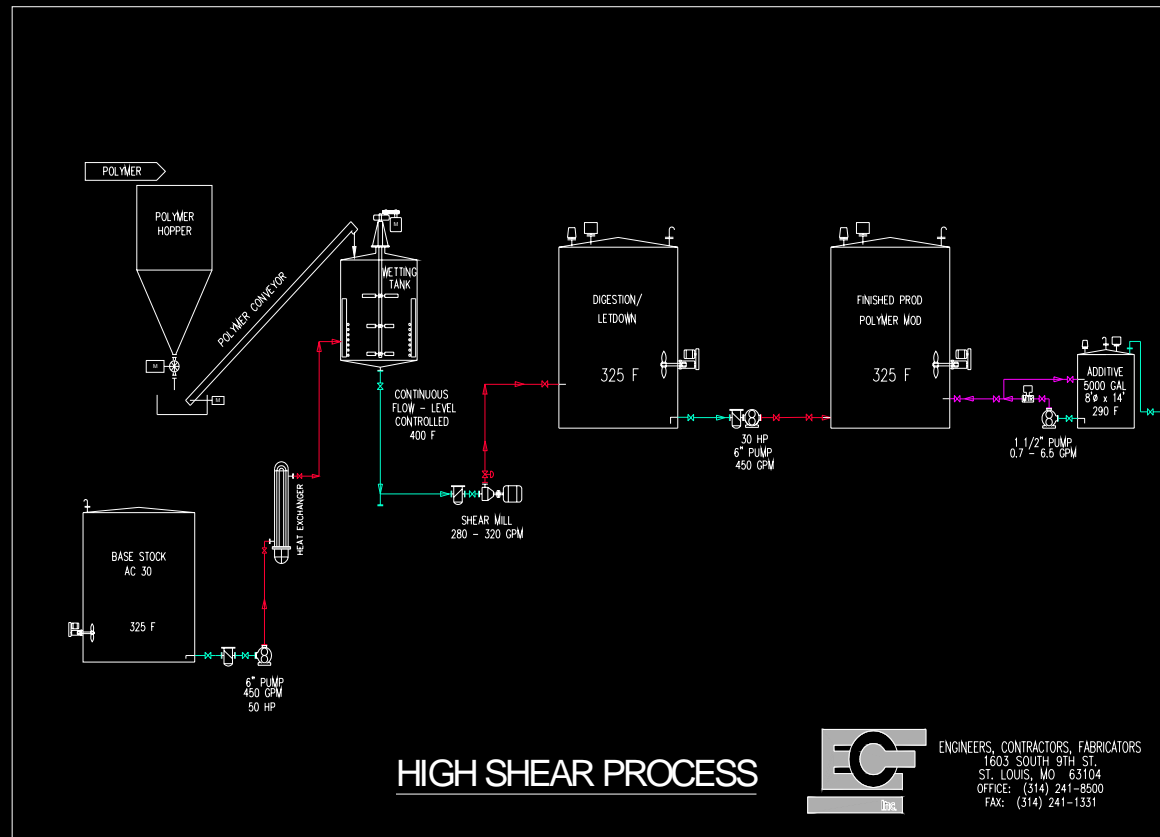
## ● Purpose

- Introduce Polymer to AC in a Smaller Tank and Shear into Smaller Particles Using a Mill, Making it easier and Quicker to Digest

## ● Description

- AC is Pre-Heated in the Same Manner as the Batch Tank Using Either a Day Tank or Heat Exchanger Then it is Pumped Into Wetting Tank at a Controlled Rate Using a Variable Speed Drive Pump.
- The Polymer is Introduced in the Same Manner as the Large Mix Tank But Using a Smaller Tank and Mixer
- Both the AC and Polymer Streams Can be Controlled to Achieve a Homogeneous AC/Polymer Stream to the Mill. This Insures Concentration Strength and Decreases Digestion Time
- This AC/Polymer Stream is Then Fed to the Mill or Homogenizer Which Shears the Polymer Particles Into Smaller Pieces Making Them Easier to Digest.

# High Shear Flow Diagram



# High Shear Process Considerations

- **Batch Sizes Can Be Varied Based on Digestion or Finished Product Tank Sizing**
- **Production Rate Variable But Industry Rates are in the 270-300 gpm Range**
- **More Flexible Because Product Can Be Re-Circulated Through the Mill or Re-Milled if Necessary**
- **Usually More Expensive to Install**
- **Concentrations Up To 15%, Best Results are Around 10%**
- **Usually Less Time Required to Produce Same Size Batch**



# Wetting Tanks



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# Mills



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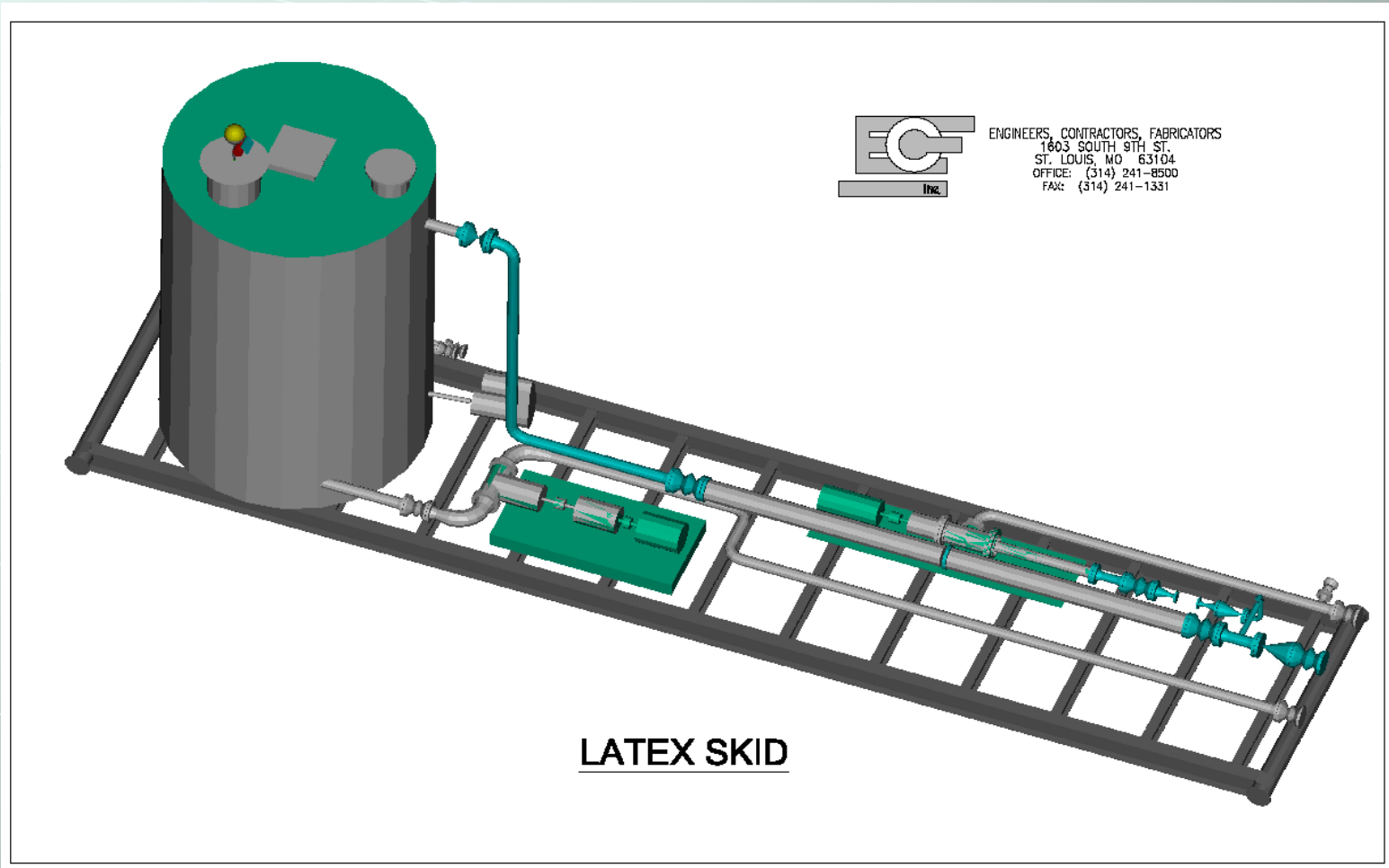


# Pre Fabricated Skids



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# Latex Skid



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# Digestion/Finished Product Tanks

## ● Good Agitation

- Side Entry Mixers
- Top Entry Mixers
- Re-Circulation Lines

## ● Adequate Maintenance Heat

- Proper Insulation
- Coils – Bare Pipe Preferred
- 280-320°F

# Additives, Cross Linking Agents, Magic Dust

- **Chemistry Dictates Where and How This Product is Added or Injected**
- **Typical Types of Linking Agents and Secondary Modifiers**
  - **Sulfur**
    - Flake
    - Liquids Blend
    - Molten
  - **Acid**
    - Liquids
  - **Other Modifiers**



# Sulfur Addition Systems

## ● Flake or Pellet

- Often Conveyed Similar to Polymer Via Hoppers and Conveyors

## ● Oil Based

- Small Injection Pumps in Re-Circulation Lines or Tank Addition

## ● Molten

- Self Contained Skid Injection Systems
- Definable Amounts Added to Re-Circulation or Directly Into Tank Top or Side.

## ● Safety Consideration

- Presence of H<sub>2</sub>S and Need for H<sub>2</sub>S Safety Program



# Molten Sulfur Skid



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# Sulfur Flake or Pellet Hopper



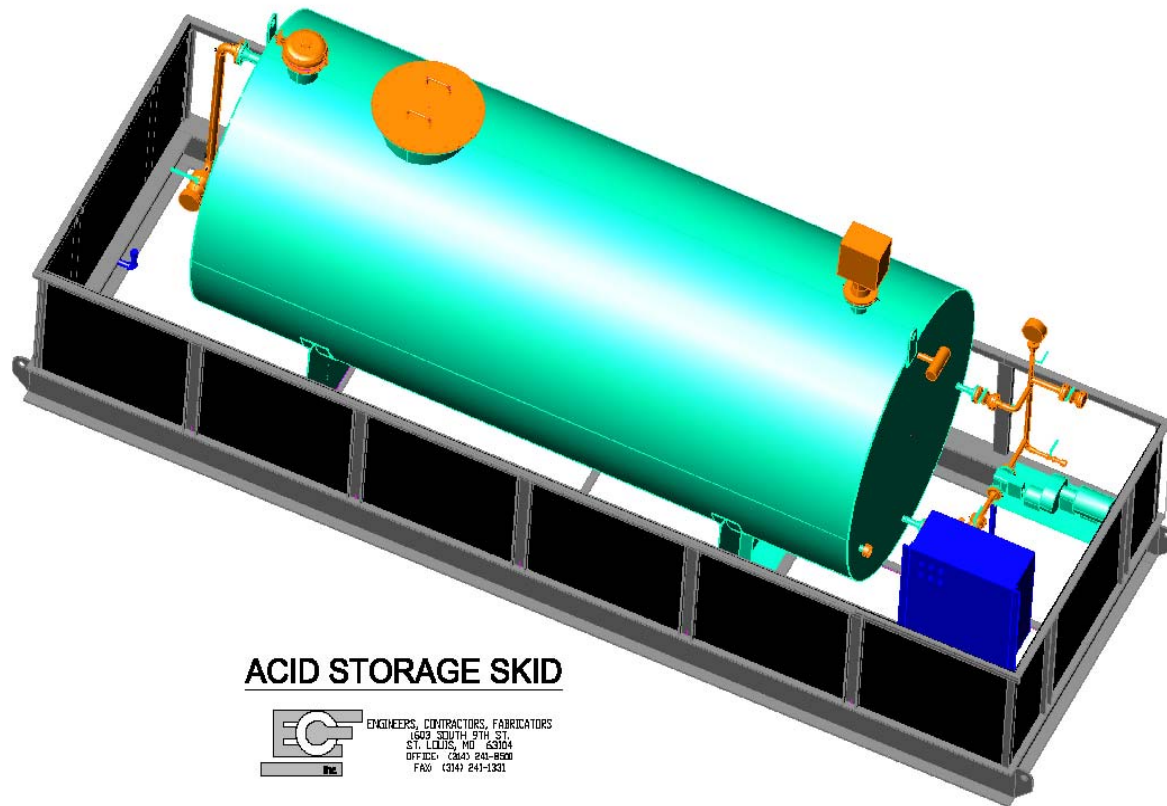
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# Acid Injection Systems

- **Self Contained Skids Provided by Vendors**
- **Ground Up Systems**
  - **All 316L SS**
  - **Narrow Temperature Band for Use**
  - **Must Have a Controllable Heating System**



# Acid Injection Skid



**ACID STORAGE SKID**



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# General Equipment Recommendations

- **Line Sizes**

- 8" Suctions, 6" Discharges

- **Strainers**

- Duplex

- **Pumps**

- Jacketed

- **Heat Exchangers**

- **Tracing**

- **Insulation**

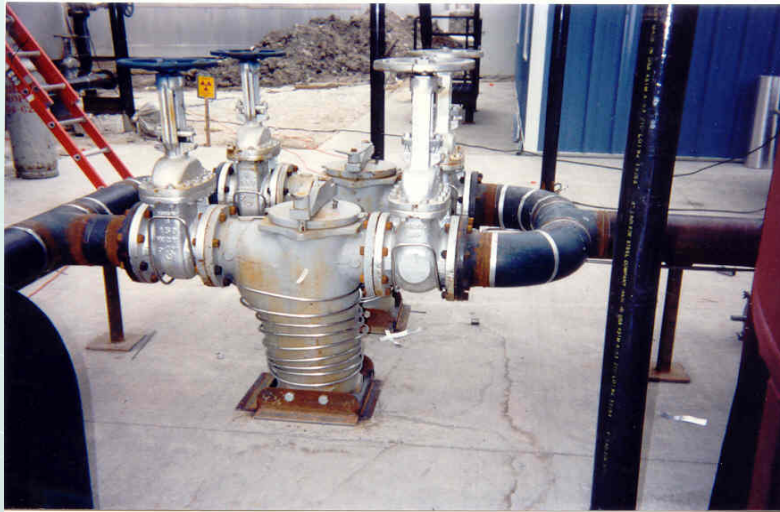
# General Equipment Photos



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# General Equipment Photos



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# Questions



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