

**DENATURED FUEL ETHANOL**  
**MANUFACTURE, PROPERTIES AND**  
**SPECIFICATIONS**

**PRESENTED AT THE CALIFORNIA PHASE 3**  
**REFORMULATED GASOLINE REGULATIONS WORKSHOP**

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**Archer Daniels Midland Co.**

**Chairman, Renewable Fuels Association Technical Committee**

## **U. S. FUEL ETHANOL PRODUCTION**

12 Corn Wet Milling Plants

31 Corn Dry Milling Plants

9 Other Sources (Wheat, cheese whey,  
potato, beverage and wood waste)

Wet Mills - 63 % of Production

Dry Mills - 35 % of Production

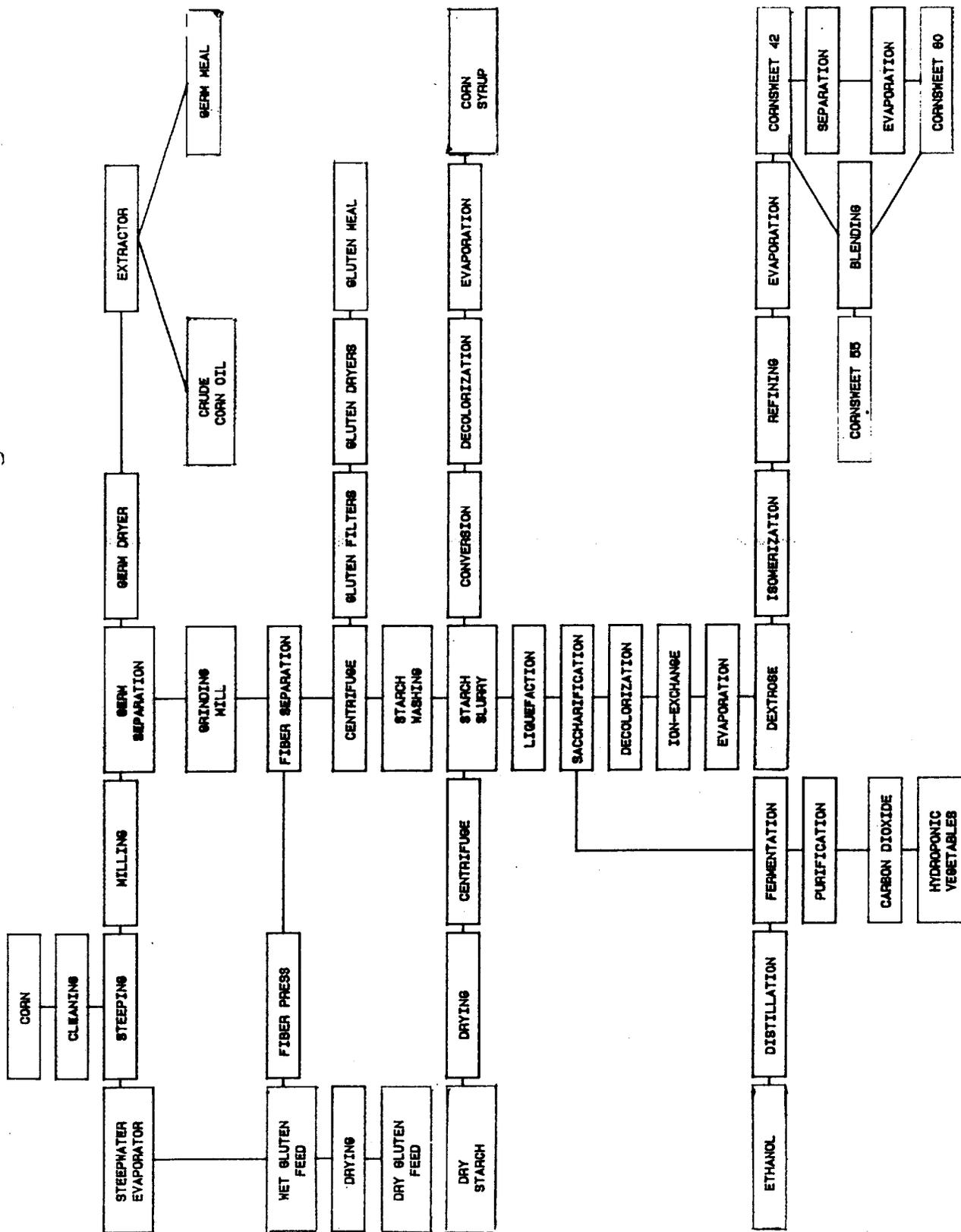
Other - 2 % of Production

## **SULFUR IN FUEL ETHANOL**

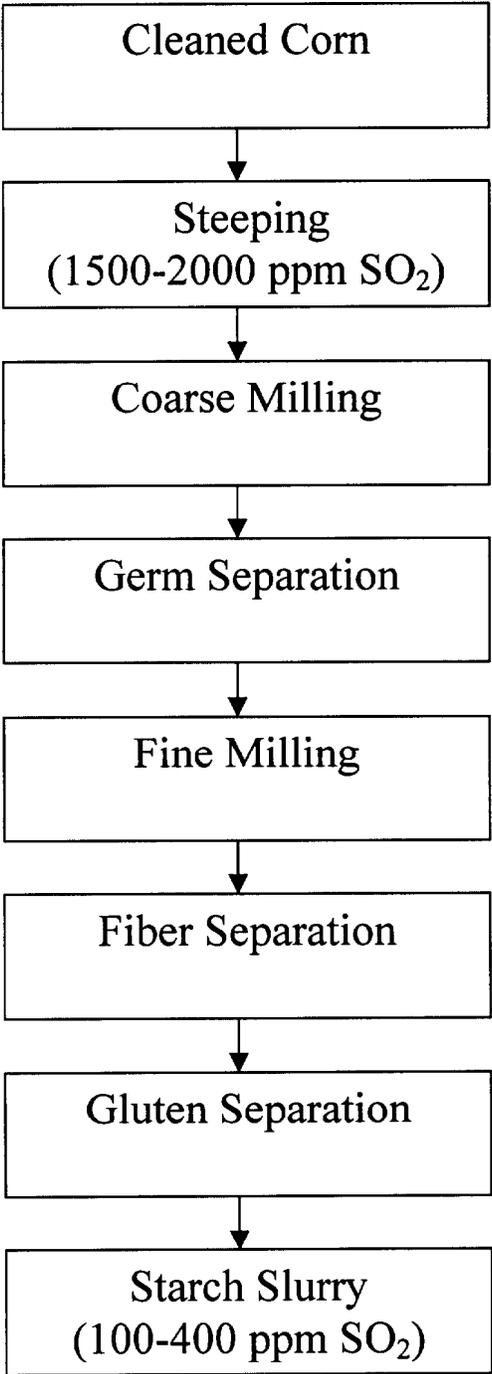
### **SOURCES OF SULFUR**

1. Ethanol Production Process
2. Denaturant

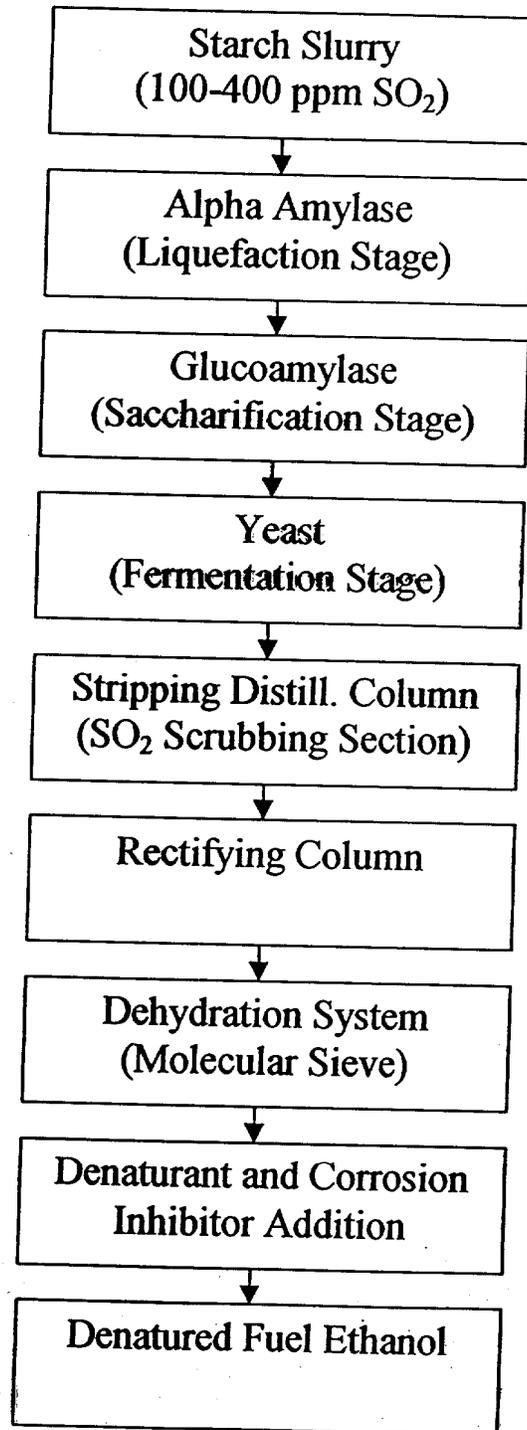
# Corn Wet Milling Process



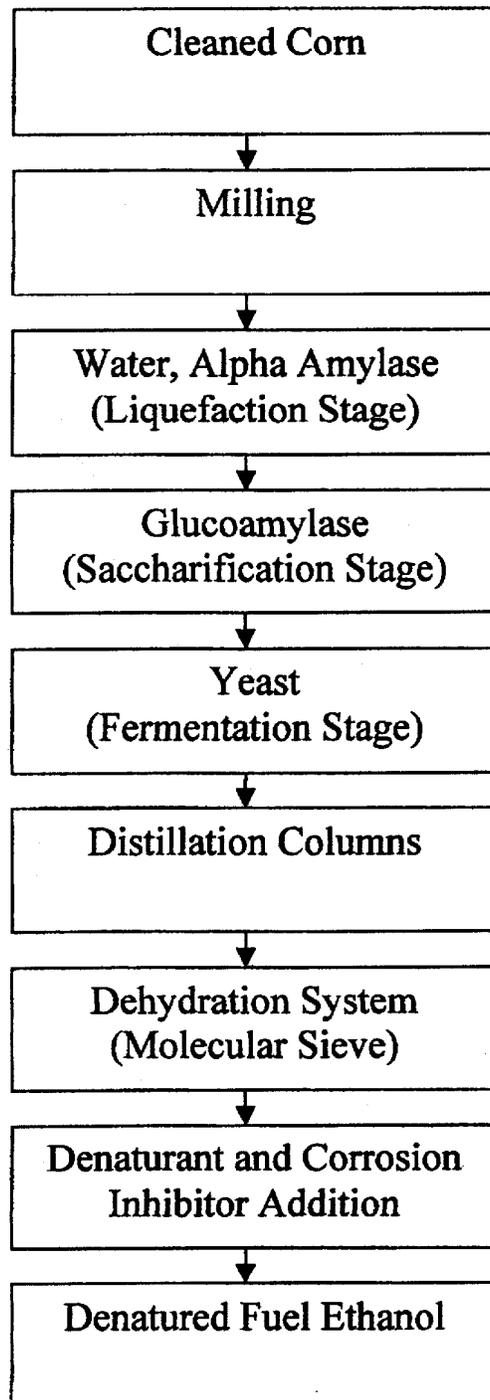
# Corn Wet Milling Process



## Corn Wet Milling Ethanol Process



## **Corn Dry Milling Ethanol Process**



**DENATURED FUEL ETHANOL  
TYPICAL COMPOSITION**

Ethanol, volume %	94.5
Other Fermentation Alcohols, volume %	0.3
Denaturant, volume %	4.6
Water, volume %	0.6
Acidity (as acetic acid) mass %	0.004
Solvent Washed Gum, mg/100mL	2
pHe	7.0
Chloride Content, mg/L, max.	2
Copper Content, mg/kg, max.	Not Detectable
Appearance	Clear and Bright
Corrosion Inhibitor	20 to 30 lbs/1000 bbl

## **CORROSION INHIBITOR IN DENATURED ETHANOL**

The Renewable Fuels Association (RFA) recommends that all fuel ethanol producers add a corrosion inhibitor to all of their fuel ethanol production.

**OBJECT:** To provide corrosion protection from points of distribution and storage to final ethanol/gasoline use.

**USAGE:** The corrosion inhibitors approved by the RFA provide fuel ethanol a B+ or better rust rating when tested by NACE TM-01-72 method.

**SUMMARY:** Field surveys show that the industry is producing ethanol with virtually 100% having NACE rust ratings of A. No samples are below B+ rating.

## **DENATURED FUEL ETHANOL**

### **TYPICAL PROPERTIES**

Gravity, API	47.5
Specific Gravity, 60°F	0.7905
Pounds/Gal., 60°F	6.58
Vapor Pressure, 100°F, psi	4.0
Blending Vapor Pressure, 5.7 to 10% in gasoline, psi	18
Oxygen Content, wt. %	33
Color	Colorless
Appearance	Clear, Free of Suspended Matter

## **FUEL ETHANOL DENATURANTS**

Denaturant Definition Specific to D4806 - natural gasoline, gasoline components, unleaded gasoline or toxic or noxious materials added to fuel ethanol to make it unsuitable for beverage use but not unsuitable for automotive use.

**PROPERTIES OF NATURAL GASOLINE  
HISTORICALLY AVAILABLE FOR  
DENATURING OF ETHANOL**

Color, Saybolt	+25 to +30
API Gravity	80 - 85
RVP @ 100°F, psi	13 - 14
Sulfur, ppm	60 - 160
Research octane number	76
Motor octane number	74
Distillation °F, Typical	
1 BP - 92	
10% - 105	
20% - 110	
50% - 125	
90% - 185	
FBP - 265	
Benzene, volume %	0.3 - 0.5
Olefins, volume %	0.1 - 0.8
Aromatics, volume %	1.0 - 2.6

## **FUEL ETHANOL PRODUCERS' RESPONSE TO CaRFG3 PROPOSED SPECIFICATION**

1. The ARB & industry need to review test methods associated with the proposed aromatic, benzene and olefin limits.
2. The ethanol industry is anxious to work with CARB and ASTM to verify an appropriate test method for sulfur in fuel ethanol.
3. It is inappropriate for the ethanol industry to commit to a sulfur specification today. Data from the supplier survey is scattered, the test methods are not known, denaturant sulfur levels are not known and several of the producers have not responded to the survey.
4. We cannot comment today on a sulfur specification until the second RFA survey is completed. We can respond at the next CARB workshop.