

**PRESENT-**

**ATION:**

**NATURAL**

**GAS 101,**

**1/19/05**



## **Natural Gas & Natural Gas Liquids**

*Presented by*  
Dennis Steffy, Director  
Mining and Petroleum Training Service



---

---

---

---

---

---

---

---

## **Natural Gas & Natural Gas Liquids**

### **Purpose:**

To establish  
Hydrocarbons  
some

---

---

---

---

---

---

---

---

## **Origin of Oil and Gas**

Oil and gas originated from the remains  
of microscopic life in shallow marine  
environments

Fossil Fuels  
are composed  
of  
hydrocarbons



---

---

---

---

---

---

---

---

## Origin of Oil and Gas

The total amount of organic matter stored this way is less than 1% of all the organic matter that has been formed by plants and animals over geologic time



LA Brea Tar Pits, Los Angeles, ca 1920

---

---

---

---

---

---

---

---

## Origin of Oil and Gas

These remains decomposed to form oil and gas

They migrated upwards until trapped by some sort of subsurface geological formation



---

---

---

---

---

---

---

---

## Natural Gas & Natural Gas Liquids

The rock where oil and gas forms is called a source rock

The process of forming oil and gas is called maturation

---

---

---

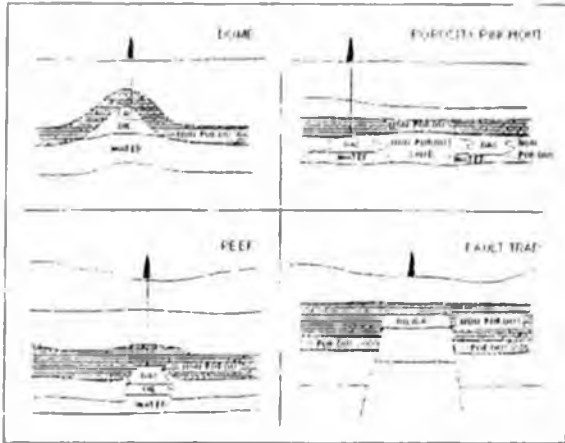
---

---

---

---

---




---

---

---

---

---

---

---

---

### Oil and Gas Reservoirs

**High Porosity and Permeability  
are good**

Porosity is open space in the formation where oil and gas can accumulate

---

---

---

---

---

---

---

---

### Oil and Gas Reservoirs

**More Porosity  
= more room for oil and gas**

Permeability is the ability of oil and gas to move through the formation

High permeability means easy and rapid movement of oil and gas to the well

---

---

---

---

---

---

---

---

## Oil and Gas Reservoirs



Organic rich limestone - a good source rock

---

---

---

---

---

---

---

---

Certain conditions of pressure and temperature are required to create petroleum - the *hydrocarbon window*

Oil forms in a *source rock* like organic shale. It migrates until it is trapped by a *cap rock*. It resides in a *reservoir rock* like sandstone.



---

---

---

---

---

---

---

---

**Reservoirs** should have high porosity, permeability



Examples, sandstone, conglomerate, cavernous limestone, highly fractured rocks (even granite)

---

---

---

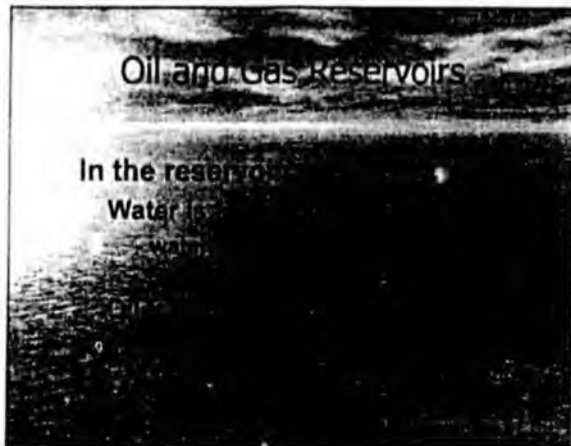
---

---

---

---

---



---

---

---

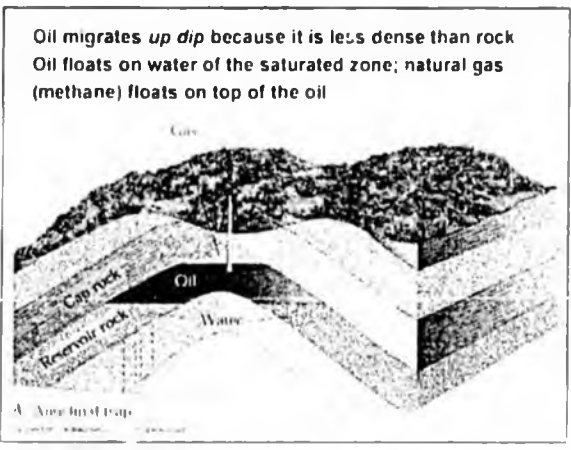
---

---

---

---

---



---

---

---

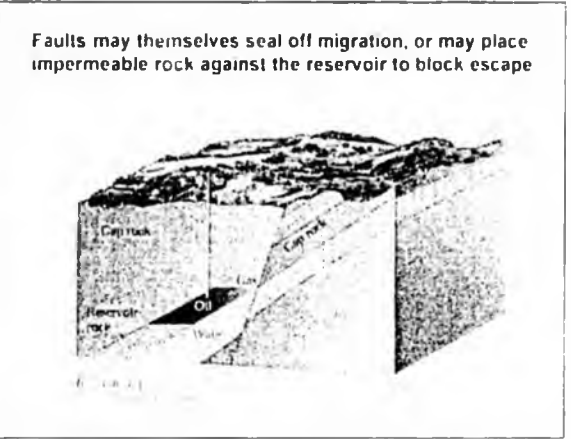
---

---

---

---

---



---

---

---

---

---

---

---

---

Angular unconformity traps oil in lower dipping layers



Figure 10.10

---

---

---

---

---

---

---

---

Fossil reefs are bulbous lenses interbedded with normal layers  
They trap oil derived from lower source rocks

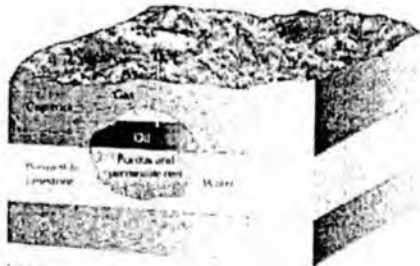


Figure 10.11

---

---

---

---

---

---

---

---

Sedimentary facies changes create lens-shaped wedges or pinch-outs that may serve as traps in some conditions

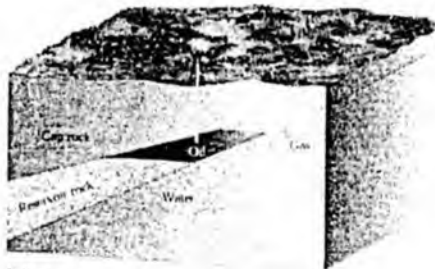


Figure 10.12

---

---

---

---

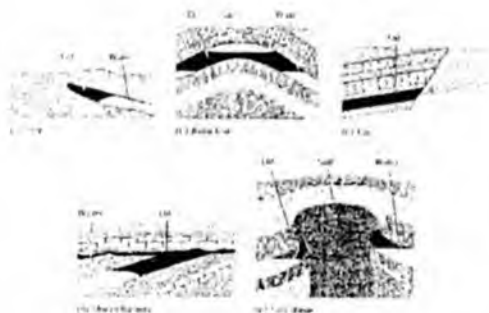
---

---

---

---

### Summary of Petroleum Traps



---

---

---

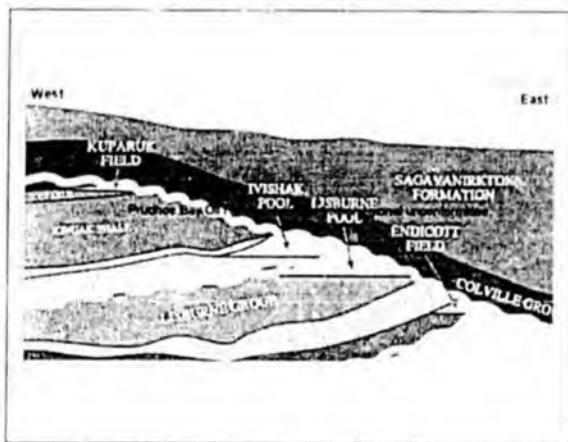
---

---

---

---

---



---

---

---

---

---

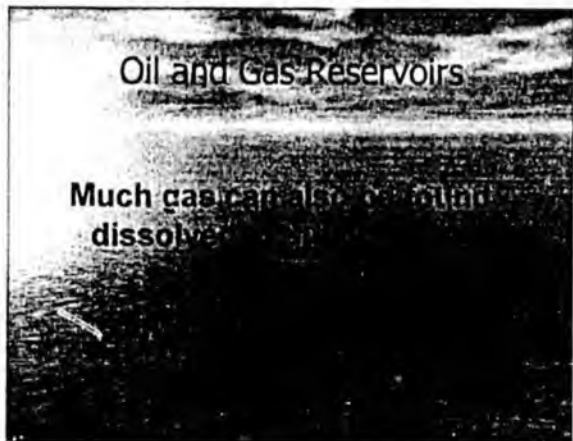
---

---

---

### Oil and Gas Reservoirs

Much gas can also be found dissolved in oil.



---

---

---

---

---

---

---

---

**THE  
FOLLOWING  
DOCUMENT(S)  
ARE  
POOR  
ORIGINAL  
COPIES**

**Oil and Gas Reservoirs**

Associated gas leaves the oil when the pressure is reduced to a certain level

Associated gas slowly leaves the oil as the reservoir pressure is reduced through production of fluids from the reservoir

---

---

---

---

---

---

---

---

**Oil and Gas Reservoirs**

The pressure generated by the formation of the oil

---

---

---

---

---

---

---

---

**Oil and Gas Reservoirs**

Energy can be used to drive

---

---

---

---

---

---

---

---



---

---

---

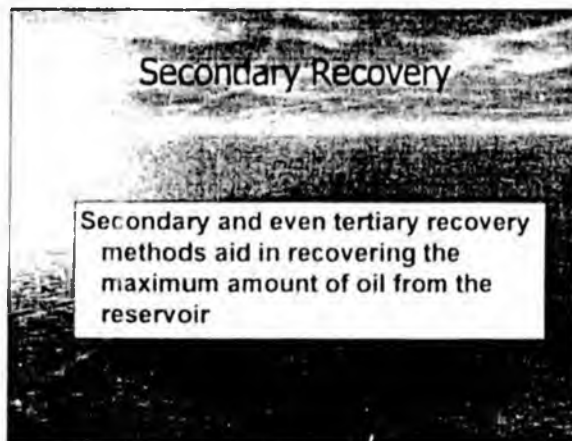
---

---

---

---

---



---

---

---

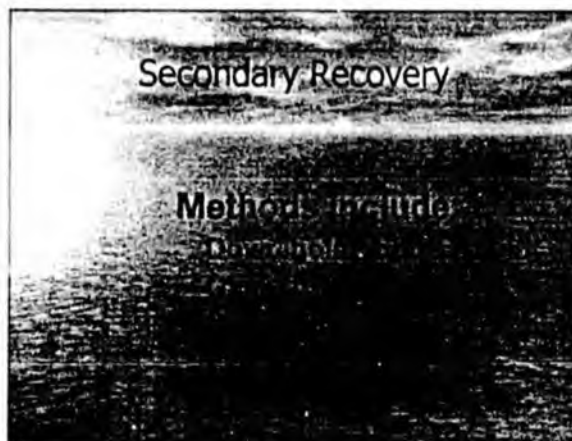
---

---

---

---

---



---

---

---

---

---

---

---

---



---

---

---

---

---

---

---

---



---

---

---

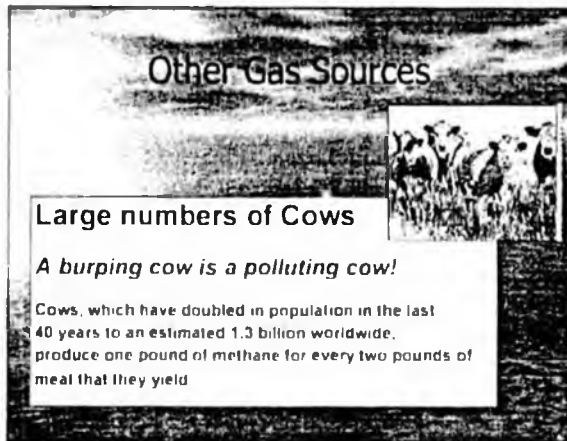
---

---

---

---

---



---

---

---

---

---

---

---

---



---

---

---

---

---

---

---

---

## Petroleum Hydrocarbons

Hydrocarbons are composed only of Hydrogen and Carbon

We will deal with rather simple hydrocarbons in this presentation

*The hydrocarbons of interest all end in the letters '-ane'*

---

---

---

---

---

---

---

---

## Physical Properties

Chemical Name	Formula	Boiling Point	Heating Value
Methane	CH <sub>4</sub>	-260 F	931 BTU
Ethane	C <sub>2</sub> H <sub>6</sub>	-127	1770
Propane	C <sub>3</sub> H <sub>8</sub>	-44	2517
Butane	C <sub>4</sub> H <sub>10</sub>	+31	3260
Pentane	C <sub>5</sub> H <sub>12</sub>	+97	4009

---

---

---


---

---



---

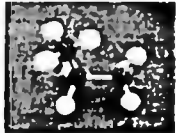
---

---



**Methane** CH<sub>4</sub>

**Ethane**  

C<sub>2</sub>H<sub>6</sub> **Propane** 

---

---

---

---

---

---

---

---

### Contaminates in Produced Gas

North Slope gas may have significant amounts of undesirable contaminants including:

- Carbon Dioxide up to 13%
- Hydrogen Sulfide up to 250 ppm
- Water

---

---

---

---

---

---

---

---

### Conditioning Natural Gas for Transmission

To transport gas in a pipeline, a "contract" establishes the maximum amounts of undesirable contaminants

---

---

---

---

---

---

---

---

## Oil and Gas Reservoirs

**A conditioning plant must be designed to meet contract specifications over the life of the project**

---

---

---

---

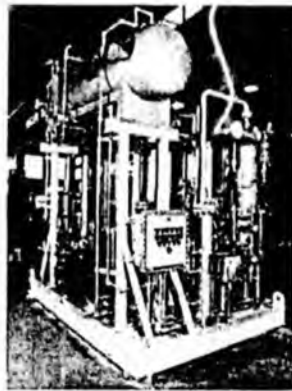
---

---

---

---

Hydrocarbon Dewpoint Control System



---

---

---

---

---

---

---

---

## Conditioning Natural Gas for Transmission

**Carbon Dioxide and Hydrogen Sulfide are called "acid gases" (often called Sour Gas) because they form acids when in contact with water.**

---

---

---

---

---

---

---

---

Conditioning  
Natural Gas for Transmission

Acid gases cause severe corrosion of process equipment and pipelines

Hydrogen Sulfide is an extremely toxic substance, immediately dangerous to life and health at very low levels

---

---

---

---

---

---

---

---

Conditioning  
Natural Gas for Transmission

The removal of 'sour gas' from a methane stream is called "sweetening" and is a part of the conditioning of gas to meet pipeline contract specifications

---

---

---

---

---

---

---

---

There are many processes to sweeten gas, however the most common is the Amine system



---

---

---

---

---

---

---

---



---

---

---

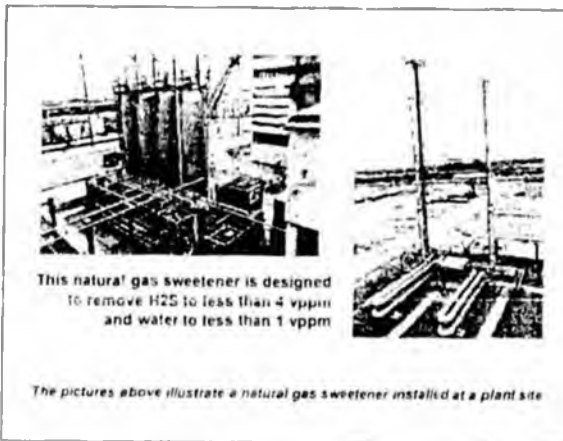
---

---

---

---

---



---

---

---

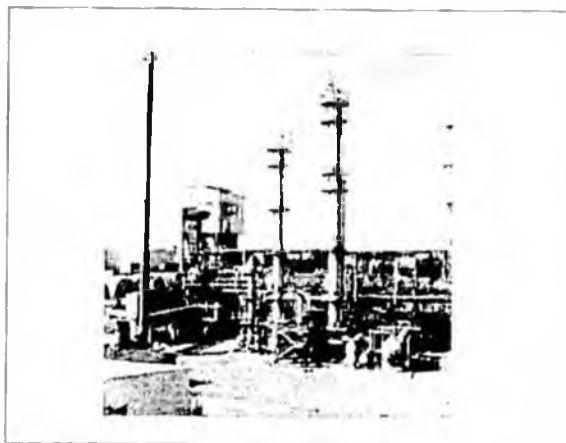
---

---

---

---

---



---

---

---

---

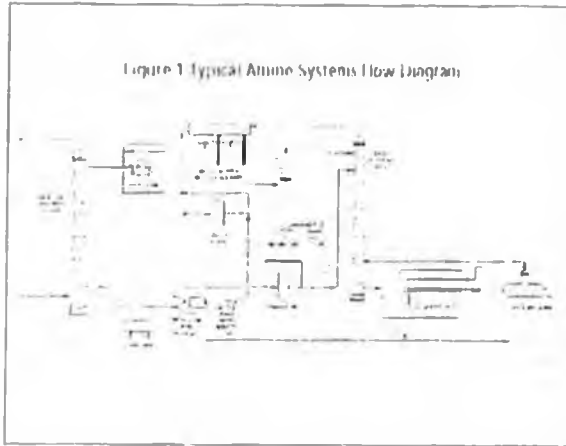
---

---

---

---

Figure 1 Typical Amine Systems Flow Diagram




---

---

---

---

---

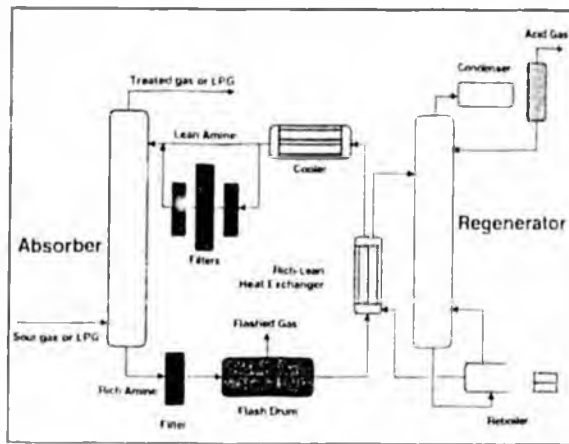
---

---

---

---

---




---

---

---

---

---

---

---

---

---

---

### MEA filtration gas sweetening unit

Gases are washed in a counter current washing column and the dissolved H<sub>2</sub>S separated in a later step using steam

Fines, worn from the piping, collect in the amine solution, which ultimately lead to blocking and foam generation in the column

Filters for cleaning these streams and discharging either wet or dry cakes have yield excellent results




---

---

---

---

---

---

---

---

---

---

**Conditioning  
Natural Gas for Transmission**

**Amine Treatment can remove  
both Carbon Dioxide and  
Hydrogen Sulfide**

---

---

---

---

---

---

---

---

**Conditioning  
Natural Gas for Transmission**

**Carbon Dioxide can be re-injected into  
the formation to maintain pressure  
and sweep oil toward the well bore**

**Removal of Hydrogen Sulfide can  
generate large amounts of elemental  
Sulfur**

---

---

---

---

---

---

---

---

**Conditioning  
Natural Gas for Transmission**

**Carbon Dioxide can form Dry Ice in  
process equipment and plug off  
critical components**

**Dry Ice must be thawed with heat to  
remove the plug**



---

---

---

---

---

---

---

---

Frozen natural  
gas shed  
In Canada



---

---

---

---

---

---

---

---

### Conditioning Natural Gas for Transmission

Water content must be reduced  
to a very low level

Water can freeze and plug  
critical process equipment

Water combines with Methane to  
form Hydrates that can plug off  
critical process equipment

---

---

---

---

---

---

---

---

### Dehydration

The most common large scale process  
for removing water from a gas stream  
is called "Glycol Dehydration"

*Glycol dehydration is used all over  
the Slope and the Inlet*

---

---

---

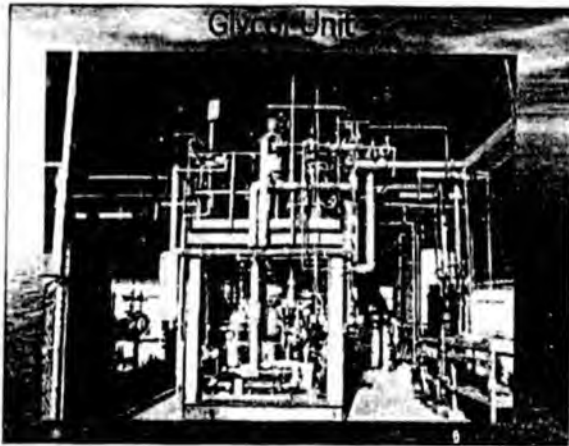
---

---

---

---

---



---

---

---

---

---

---

---

---

## Dehydration

Cold Glycol can absorb large amounts of water vapor

When heated, the Glycol then gives up the water vapor and can be cooled and reused

Large equipment would be required to handle the amounts of gas contemplated by the North Slope gas line

---

---

---

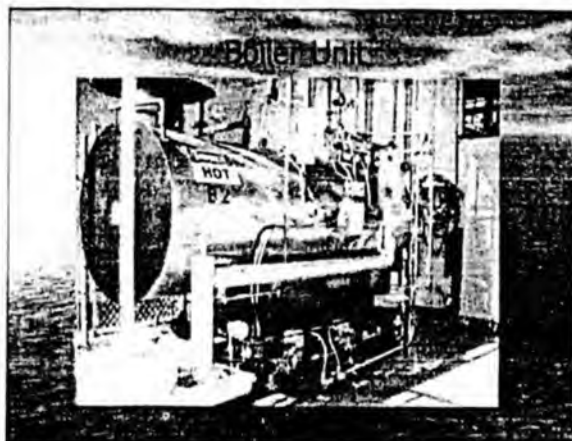
---

---

---

---

---



---

---

---

---

---

---

---

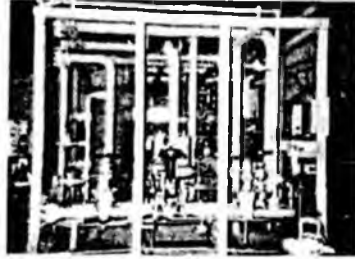
---

### Natural Gas Drying & NH3 Removal

This design is capable of removing moisture and ammonia from natural gas through it's adsorption process

The system is capable of taking saturated feed gas and returning dry gas with less than 0.1 ppmv of water

In addition, NH3 is removed down to less than 0.2 ppmv



The pictures above depict a natural gas dryer prior to shipment

---

---

---

---

---

---

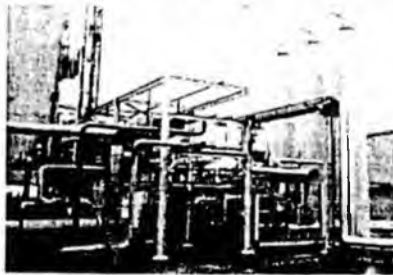
---

---

---

---

This LNG Prepurifier is designed to remove moisture, CO2, and mercaptans from natural gas taken from a pipeline



This allows the LNG facility to liquify excess quantities during periods of low use and store them until they can be vaporized at a time of need

---

---

---

---

---

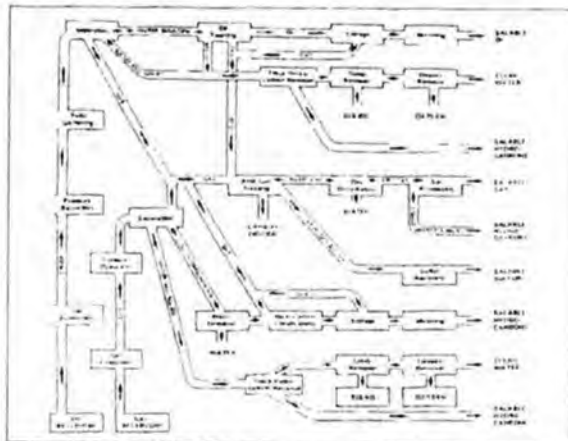
---

---

---

---

---



---

---

---

---

---

---

---

---

---

---

**Gas Custody  
and Custody Transfer**

**The volume of gas transferred from seller  
to buyer is measured in SCF (Standard  
Cubic Feet), measured at 14.7 psi and  
60 degrees F**

**Alternate specifications are more  
commonly stated in metric units**

---

---

---

---

---

---

---

---

**Gas Custody  
and Custody Transfer**

**The Heating Value of the gas in  
BTU's per cubic foot is an  
essential sales parameter**

---

---

---

---

---

---

---

---

**Gas Custody  
and Custody Transfer**

**Pure Methane generates 931 BTU**

**Penalties may be assessed when the BTU  
value is below contract specifications**

**The heating value is measured in a calorimeter  
that burns a carefully measured amount of gas  
under controlled conditions and measures the  
heat produced**

---

---

---

---

---

---

---

---

## Gas Custody and Custody Transfer

### Standard Units for Gas Measurement

**MCF** 1000 cubic feet=(10'x10'x10')

**MMCF** Million Cubic feet=1000xMCF  
100'x100'x100'

**BCF** Billion Cubic feet=1000XMMCF  
1000'x1000'x1000'

**TCF** Trillion Cubic feet-1000xBCF  
10,000'x10,000'x10,000'

---

---

---

---

---

---

---

---

## Stranded Gas

**Stranded Gas is Gas that is  
*not yet connected*  
to a transportation system**

---

---

---

---

---

---

---

---

## Shrinkage

**Shrinkage is the loss of gas used to  
process and transport the product**

Fuel for power generation

Fuel for facility heating

Fuel for compressors and process  
equipment

Incidental losses through leaks, flares,  
carryover, etc.

---

---

---

---

---

---

---

---

## Shrinkage

### Typical Shrinkage numbers:

-4% to 5% for pipeline compression, the longer the line the greater the shrinkage, up to 8%

-1% to 4% for gas conditioning, probably greater on the Slope

-14% to 17% for LNG production

---

---

---

---

---

---

---

---

## Contract Price

The price paid for long-term agreements or agreements to purchase an established volume of gas over a specific time period

*Tied to the standard price per BTU for energy*

---

---

---

---

---

---

---

---

## Spot Market

Prices bid for short term or one-time purchases

Traded as commodities

Prices vary according to amounts in storage, anticipated weather conditions and international markets

---

---

---

---

---

---

---

---

*Trading Floor at a Natural Gas Marketing Company*



---

---

---

---

---

---

---

---

### Storage Gas



In the lower 48 where demand is greater than local supply, gas is stored underground in reservoirs during periods of low demand and retrieved when demand increases above local supply

*Suppliers can control amounts of gas sold for storage and influence later prices*

---

---

---

---

---

---

---

---

### Storage Gas



Sometimes gas can be purchased at lower cost during off-peak times and stored for later use

Storage gas maximizes the use of long distance pipelines that can ship at full capacity more gas than is required, and the excess stored against times of increased demand

---

---

---

---

---

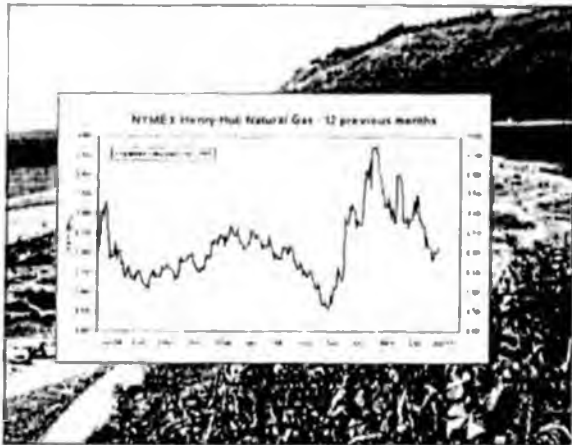
---

---

---








---

---

---

---

---

---

---

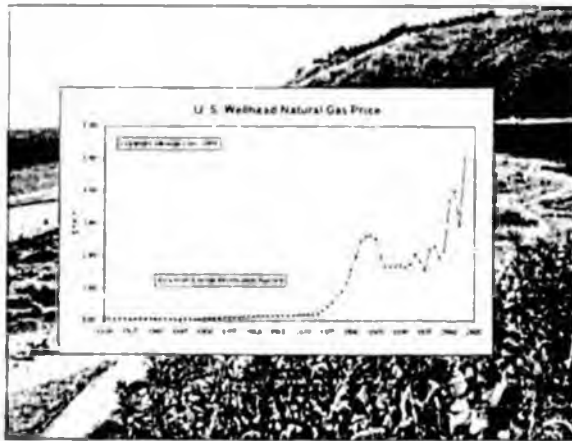
---

---

---

---

---




---

---

---

---

---

---

---

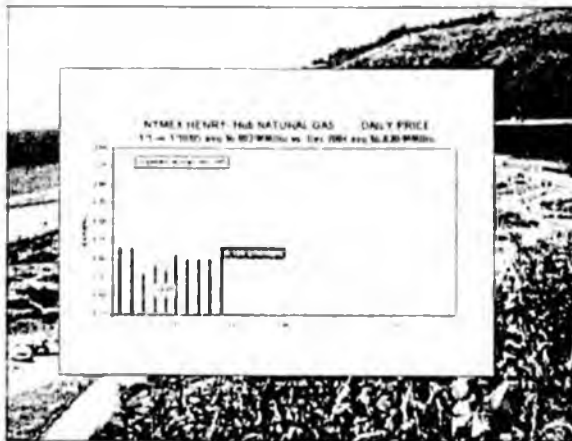
---

---

---

---

---




---

---

---

---

---

---

---

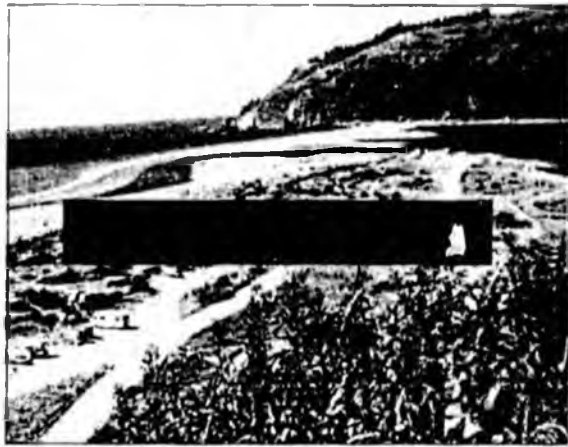
---

---

---

---

---



---

---

---

---

---

---

---

---