Reducing Methane Emissions Provides Operating Benefits for International Oil and Gas Companies: A Case Study

Oil and Gas Methane Emissions Reduction Workshop

Tomsk, Russia

14-16 September 2005

Methane to Markets

Agenda

- How can new technologies save money?
- Centrifugal compressor dry seals
- Acid gas removal using membranes
- Conclusions

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How Can New Technology Save Money?

- New technologies can:
  - **Lower capital costs**
  - **Decrease operating costs**
  - **Reduce labor requirements**
  - **Increase reliability**
  - **Increase safety**
- Other benefits include reduced methane emissions and carbon market credits

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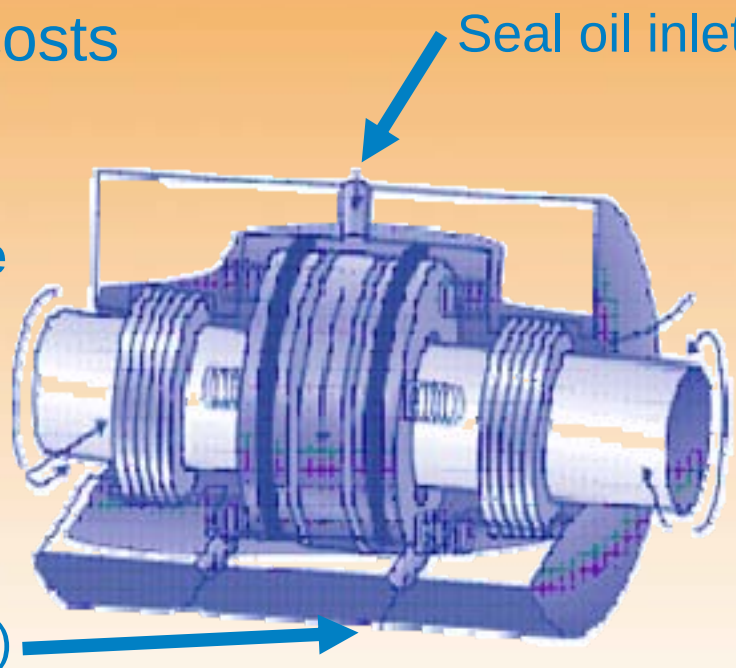
Compressor Wet Seals: What is the Problem?

- Seal oil circulates between rings around the compressor shaft
- Seal oil absorbs methane
  - **Methane removed from seal oil is vented to atmosphere**
- Wet seals have high operating costs
  - **Seal oil replenishment**
  - **Oil pump maintenance**
  - **Pipeline flow efficiency decrease**
  - **Seal power losses**



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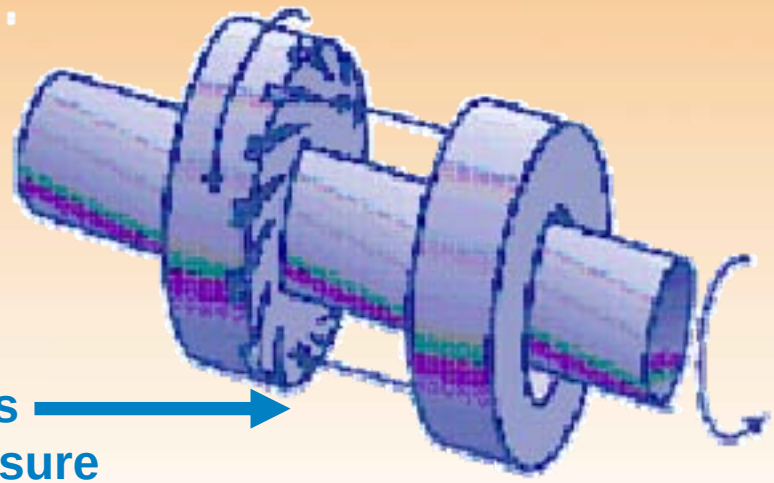
Reduce Operating Costs with Dry Seals

- Dry seals prevent methane leakage with a high-pressure gas barrier
  - **At high rotation speed, seals pump gas (instead of oil) between the seal rings, creating a barrier to leakage**
- Only small volume of gas escapes through seal gap
- Two seals are often used in tandem
- Large operating cost savings over wet seals
  - **No seal oil**
  - **No seal oil pump**
  - **Less pipeline drag**



Rotating grooves create high-pressure between seals

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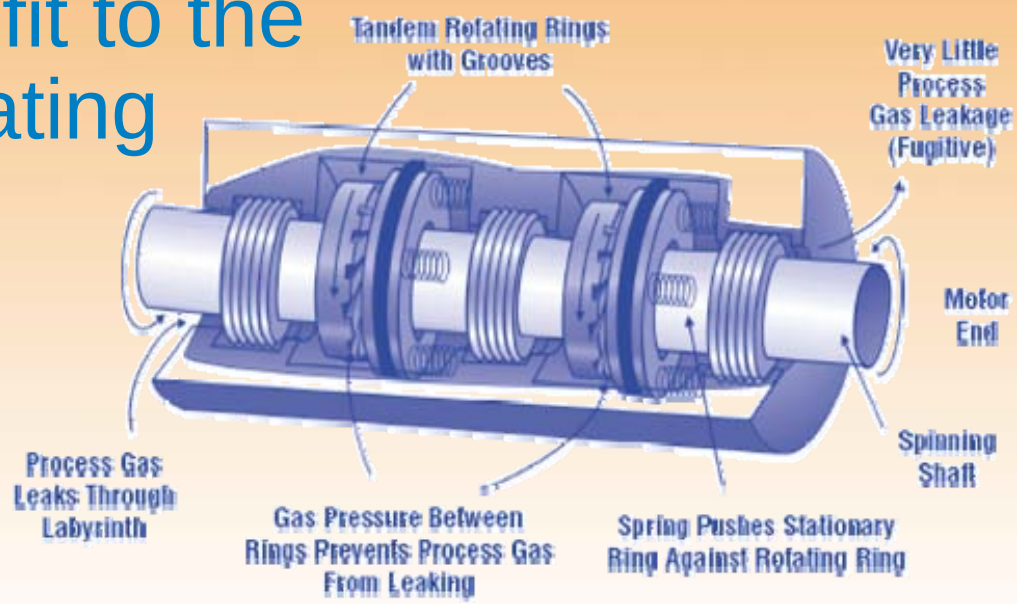
Methane Recovery with Dry Seals

- Dry seals typically leak at only 0.01 to 0.08 m^3 / minute
  - **Significantly less than the 1.1 to 5.7 m^3 / minute emissions from wet seals**
- Methane savings are a secondary benefit to the up to 94% operating cost savings



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Dry Seals: Economic Benefits

COSTS AND BENEFITS OF REPLACING WET SEALS WITH DRY SEALS IN CENTRIFUGAL COMPRESSORS (United States costs)	
Dry Seal Capital Cost:	$4,000 per centimeter of shaft diameter
Incremental Capital Cost over Wet Seals:	$1,600 more per centimeter of shaft diameter assumes seal oil equipment already purchased
Dry Seal Annual Operating Cost:	$6,000 to $10,000
Incremental Annual Operating cost versus Wet Seals:	$94,000 less
Annual Methane Savings:	Up to 2 million m^3
Example Economics for Centrifugal Compressor with a 15 centimeter shaft diameter	
Payback Period	54 months, not including carbon credit revenue
Carbon Credits	18,000 Tonnes CO_2 equivalent

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Acid Gas Removal: What is the Problem?

- Wellhead natural gas often contains acid gases: H_2S and/or CO_2
  - Corrosive to production, transmission and distribution equipment
  - Do not meet pipeline quality limits
- Acid gas removal processes typically use diethanol amine (DEA) to absorb acid gas
  - DEA process requires expensive equipment and costly operation and maintenance
  - DEA also absorbs and vents methane to the atmosphere with CO_2

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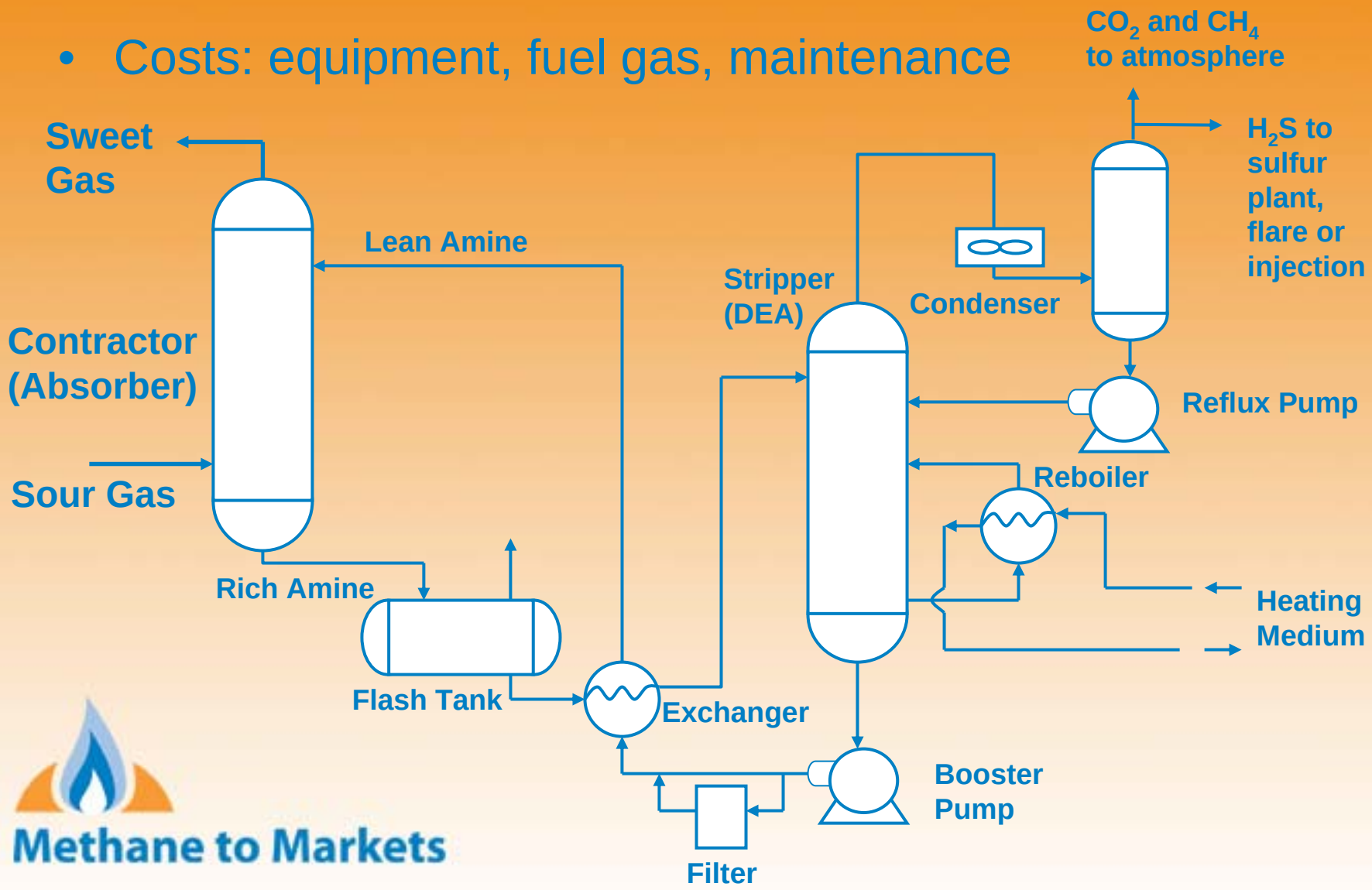
Typical Amine Process

- Costs: equipment, fuel gas, maintenance



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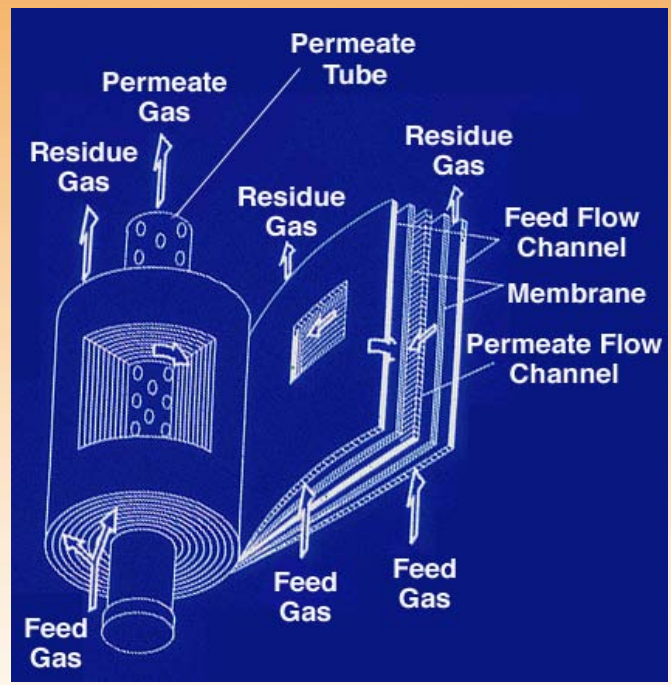
Reduce Capital and Operating Costs with Membranes

- Natural gas containing CO_2 flows alongside a membrane
  - **CO_2 permeates through membrane more readily than methane**
  - **Residue gas is depleted in CO_2 content**
- Up to 65% less capital cost and 90% less operating cost than DEA unit



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Acid Gas Removal: Economic Benefits

COSTS AND BENEFITS OF MEMBRANE ACID GAS REMOVAL OVER DIETHANOL AMINE ACID GAS REMOVAL (United States costs)	
Membrane Unit Capital Cost:	$1.5 to $1.7 million
Incremental Capital Cost over Diethanol Amine Unit:	$3 to $3.3 million less
Membrane Unit Annual Operating Cost:	$0.02 to $0.05 million
Incremental Annual Operating Cost over Diethanol Amine Unit:	$0.45 to $0.48 million less
Annual Methane Savings:	62,000 m^3 for average United States acid gas removal unit
Example Economics for a 630 thousand cubic meter per day process unit	
Payback Period	33 months
Carbon Credits	200 Tonnes CO_2 equivalent

All numbers based on 630 thousand m^3 per day unit

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Conclusions

SUMMARY OF METHODS TO ACHIEVE OPERATIONAL ADVANTAGES AND REDUCE METHANE EMISSIONS			
Technology	Gas Saved Annually	Primary Benefit	Cost Comparison to Existing Technology
Centrifugal Compressor Dry Seals	**2 million m^3 for each installation**	**•Less operating cost**	**40% more capital cost 94% less operating cost**
Acid Gas Removal by Membrane	**0.06 million m^3 for average acid gas removal unit**	**•Less capital cost**	**65% less capital cost 90% less operating cost**
Solid Desiccant Dehydration*	**0.003 million m^3 for every million m^3 dehydrated**	**•Less capital cost**	**35% less capital cost 25% less operating cost**

*Described in the accompanying paper

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Conclusions

- New technologies simultaneously increase profits, reduce methane emissions and generate carbon credits
- New technologies can have lower capital and operating costs
- Carbon credits from methane emission reductions are an important secondary benefit

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