A University/Industry Consortium for Natural Gas Production, Transmission, and Storage Systems Optimization

The University of Oklahoma
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Objectives

- Establish an Industry/University Consortium
- Receive intellectual and financial support from industry
- Align academic research with industry needs
- Create and transfer technology that the industry needs now

Today’s Objectives

- Provide basic information about the Consortium structure and general plans.
- Propose some research areas and topics for your feedback.
- Get direction from you on other research topics that are important.
- Get direction from you on the overall concepts of the Consortium.

Main Themes

- Overlay financial considerations onto the physical system
  - Reservoirs, plants, pipeline, storage
  - Contracts, operational costs, investment costs
- Adapt a broader system’s view rather than focus on subsystems
  - Coordination across the supply chain
  - Coordination across physical subsystems
Major Research Areas

- Monitoring and Surveillance
- Supply and Demand Management
- Repair and Maintenance
- Storage and transportation
- Design of surface and gas processing facilities (Sweetening, Gas plants, LNG plants, etc)
- Science-Based Models in Support of Intelligent Gas Facility Emissions Regulation
- Gas Solubility
- Leak Detection
- System Maintenance Modeling and Planning

Similar Consortia and Professional Organizations

<table>
<thead>
<tr>
<th>Name</th>
<th>Administration Structure</th>
<th>Physical Systems</th>
<th>Financial Planning</th>
<th>Focus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas Consortium (NGC)</td>
<td>University/Industry</td>
<td>Yes</td>
<td>Yes</td>
<td>Transmission, Storage and Distribution</td>
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<tr>
<td>Gas Technology Institute (GTI)</td>
<td>Private non-profit</td>
<td>Yes</td>
<td>No</td>
<td>Supply, Delivery, End use distributions</td>
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<tr>
<td>Pipeline Research Council International, Inc. (PRCI)</td>
<td>Private non-profit</td>
<td>Yes</td>
<td>No</td>
<td>Design, Construction &amp; Operations, Materials, Corrosion &amp; Inspection, Compressor &amp; Pump Station, Underground Storage</td>
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<tr>
<td>Natural Gas Storage Technology Consortium (GSTC)</td>
<td>University/Industry</td>
<td>Yes</td>
<td>No</td>
<td>Storage systems</td>
</tr>
<tr>
<td>Gas Machinery Research Council (GMRG)</td>
<td>Private non-profit (under SGA)</td>
<td>Yes</td>
<td>No</td>
<td>Compression facilities</td>
</tr>
</tbody>
</table>

Natural Gas Facility Emission Regulations

- Problem: the disconnect between EPA regulators and industry realities, discovered by
  - Direct feedback from industry
  - EPA feedback solicitation document available at EPA’s web site

- Proposed solution
  - OU becomes a neutral, independent third party to work with both sides
    - Develop science-based models of NG facilities with respect to their emissions properties
    - Create a decision support tool for scientifically accurate evaluation of regulation policies

Sample Research Topics

Part I - Research Being-Formulated or In-Progress
Comments and Input Welcome
Salt-Cavern Storage Diagnostics and Management

- Install and test the improved storage instrumentation and management technologies
- Provide improved insights and understanding of the inventory analysis and integrity assessment approaches.

Gas solubility in liquids

- Carry out gas dissolution tests at required conditions using a PVT cell.
- Measure the gas solubility and its parameters.
- Develop empirical correlations.

Optimization Tools for Preventive Maintenance

- Determine optimum of:
  - Preventive Maintenance for each equipment
  - Inventory levels
  - Personnel
  - Corrective Maintenance Priorities
- Can be used in conjunction with existing software (SAP, ORACLE, etc)
- We use Montecarlo Simulations and Genetic Algorithms

Leak and Abnormal Situation Detection and Identification

- Determination of leak location and size using:
  a) Redundant measurements
  b) Modeling
  c) Appropriate Hardware
- Diagnosis of Abnormal situations involving many phases, unknown conditions, etc.
- Key Technologies:
  - Mathematical Models
  - Data Reconciliation Techniques
Pipeline Network Design

- We propose to use Mathematical Optimization addressing:
  1. Changing demand
  2. Uncertainty and Financial Risk
  3. Future Looping
  4. Future increased Capacity
  5. Pressure changes through time

- Key ingredients:
  1. Mathematical Models of flow
  2. Modern optimization techniques

- Much more powerful than J-Curve Analysis

Management and Coordination of Contracts

Sample Research Topics

Part II – Collected from the Literature
Comments and Input Welcome

Production and Facility Planning

- Given
  1. estimated reservoir capacities
  2. availability of storage facilities
  3. configuration of existing facilities (gathering network, compressors, valves, processing plants)

- Find
  1. the production plan for the reservoirs and the facilities building schedule

- Such that
  1. demand is satisfied
  2. operational and investment costs are minimized
Some Other Topics

- Optimal design of LNG gas plants
- Minimizing fuel burning costs in pipeline operations

Potential Participants in the Proposed Consortium

- Gas Producers
- Pipeline Operators
- Local Distribution Companies (LDC)
- Natural Gas Marketing Companies
- Storage operators
  - Salt Cavern
  - Aquifers

Benefits to Industry

- Solutions to Problems of Practical Interest in Industry
  - Reports, Website, Clearinghouse
  - Specific Consulting Projects
- Cost Sharing of Research across Members
- Education Services to Industry
  - Short Courses
- Direct Access to Students with Expertise in Modern Tools and Technology

Benefits to the University

- Experience and Education for Students
  - Prepared for working in industry
- Real World Research Projects
- Interaction and guidance from Industry
- Funding support
Industry Comments and Feedback

- Do you like the proposed research topics?
- What do you think about the organization?
- What other topics would you like to see?
  - We have a PhD Student available now to work on a topic of interest.
  - Would you provide data, case study info, priorities, mentoring to this student to include real-world perspective in the research?

OU Participant, Faruk Civan

- Professor of Petroleum Engineering
- Research Areas
  - Natural gas engineering, measurement, processing, hydrates, transportation, and storage.
  - Corrosion protection in oil and gas wells.
  - Reservoir and well analyses, modeling, and simulation, and flow assurance
- Industry Experience
  - Consultant, Petrolite Corporation
  - Reservoir Engineering Consultant, Ensher Exploration, Inc.
  - Reservoir Engineering Consultant, Mobil Research and Development Corporation, Dallas Research Division

OU Participant, Miguel Bagajewicz

- Professor of Chemical Engineering
- Research Areas
  - Data reconciliation and leak detection in pipeline networks
  - Instrumentation upgrade to improve leak detection in process plants and pipelines
  - Refinery operations with pricing and financial risk management
  - Energy efficiency and carbon emission reductions
- Industry Experience
  - Process Design- Heavy Water Plant (Argentina).
  - Simulation Sciences (Simsci), USA.
  - OK-Solutions (own company). Several projects with Shell, ConocoPhillips, Ecopetrol, Pemex and others

OU Participant, F. Hank Grant

- Professor of Industrial Engineering
- Research Areas
  - Simulation and Simulation Languages
  - Electromagnetic Compatibility
    - “What Cell Phones Do to Things”
  - Inventory and Logistics Systems
- Industrial Experience
  - Founder, Pritsker Corp.
  - Founder, FACTROL
  - Consultant, numerous Fortune 500 Companies
  - Lab Director, Hewlett Packard Laboratories
  - Program Director, National Science Foundation