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**Shelby Oostwouder**  
**GAS/SPEC Technology Group**

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### INEOS

INEOS LLC  
Head Office  
2925 Briarpark Drive, Suite 870, Houston, TX 77042  
713.243.6200 main 866.865.4747 customer service  
[www.ineosllc.com](http://www.ineosllc.com)

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# The Advantages of GAS/SPEC CS-2000 for the Ammonia Producer

by

Mr. Shelby Oostwouder,  
Business Manager - GAS/SPEC,  
INEOS LLC,  
GAS/SPEC Technology Group,  
Houston, Texas.

## The GAS/SPEC Technology Group

The GAS/SPEC\* Technology Group was formed in 1982 to provide gas treating products, services and technologies to the natural gas, refining and ammonia producing industries. These technologies used primarily amine-based technologies, which The Dow Chemical Company had developed over several decades. The primary amine molecule used for most of the applications was methyldiethanolamine (MDEA), and the primary application was to remove hydrogen sulphide (H<sub>2</sub>S) and carbon dioxide (CO<sub>2</sub>) from various hydrocarbon streams. The products often have additives formulated into the MDEA to enhance performance in specific applications.

Rather than simply selling a product, the GAS/SPEC group provides a large number of services to assist customers in the optimization of their plants. These services can include design assistance for new plants, simulation of performance of new products in existing equipment, start-up support, and ongoing analytical support and consultation. These services allow plant operators to maximize throughput, reduce operating and maintenance expenditures, and minimize downtime.

Some of the most demanding applications for amine systems are in the area of deep CO<sub>2</sub> removal without the presence of H<sub>2</sub>S. Typical CO<sub>2</sub> only applications include coal seam gas treating, refinery hydrogen unit treating, and hydrogen treating in ammonia production. When the GAS/SPEC group was formed, many of these applications used monoethanolamine (MEA) in combination with various heavy metal inhibitors. MDEA products, which do not require inhibitors, have now

replaced most of the MEA in these systems. But these MDEA products all have some limitations such as preferential additive loss, additive degradation, or limited operating concentrations.

## GAS/SPEC CS-2000 Development

To assist customers requiring ever-increasing capacity requirements without expensive equipment change-outs or modifications, GAS/SPEC CS-2000 solvent has been developed. This product provides a combi-

Table 2

Comparison of Carbon Steel Corrosivity  
of other MDEA Formulations with  
GAS/SPEC CS-2000

Formulation	Carbon Steel Liquid Corrosivity <sup>a</sup>
Formulation 1	58 mpy <sup>b</sup>
Formulation 2	5 <sup>b,c</sup>
GAS/SPEC CS-2000	<1 <sup>c</sup>

a) mpy is mils per year.

b) 400 psig CO<sub>2</sub>, 248°F for 7 days.

c) 260°F, 0.05 mol/mol CO<sub>2</sub> for 28 days.

Table 1

Comparison of Accelerated Degradation  
of other MDEA Formulations with  
GAS/SPEC CS-2000

Formulation	Start wt. %	Finish wt. %
Formulation 1	50	27.8 <sup>a</sup>
Formulation 2	50	42.7 <sup>a</sup>
GAS/SPEC CS-2000	50	49+ <sup>b</sup>

a) 400 psig CO<sub>2</sub>, 248°F for 7 days.

b) 260°F, 0.05 mol/mol CO<sub>2</sub> for 28 days.

nation of deep CO<sub>2</sub> removal coupled with lower energy, higher capacity and long term stability when compared to the solvents that were previously available.

To improve the degradation characteristics, especially in severe applications, an extensive research program was undertaken. To evaluate the solvents, accelerated CO<sub>2</sub> degradation tests were utilized to compare the various solvents. The GAS/SPEC CS-2000 product has noticeably decreased the degradation versus other commercially available products (see Table 1). Note that the MDEA portion of each solvent has very little degradation; it is the promoter that has the most significant degradation due to high CO<sub>2</sub> loading in combination with high process temperatures.

Next, the test solutions were evaluated for corrosivity using carbon steel weight loss coupons. This test verifies the improvement in solvent stability and the benefit of reduced solution corrosivity (see Table 2).

# GAS/SPEC CS-2000



Stripper packing prior to GAS/SPEC CS-2000 (above left) and with GAS/SPEC CS-2000 (above right).

The relative improvement from the first generation solvents to the second-generation material was good, but GAS/SPEC CS-2000 solvent further improved stability and solvent corrosivity.

In the ammonia industry, blends of MDEA and piperazine remain popular because of its experience in taking advantage of low energy designs. <sup>1</sup> MDEA / piperazine blends are calculated to have about 15-30% less capacity than GAS/SPEC products, <sup>2</sup> due to piperazine carbamate solubility limitations. The degradation study was one aspect of verification of additive losses and thus solvent stability with the new solvent. The other is preferential loss of additive due to differences in vapour pressure from MDEA. When compared to piperazine in a typical MDEA-piperazine formulation, GAS/SPEC CS-2000 additive has lower vaporization losses. <sup>3</sup> (see Figure 1). This important factor can affect not only the long term chemical makeup costs of the plant but also the amount of operator attention required to keep the plant treating in specification.

Finally, the GAS/SPEC CS-2000 solvent was found to have excellent kinetics and CO<sub>2</sub> capacity for the CO<sub>2</sub> removal/regeneration cycle while also having a very low potential for CO<sub>2</sub> side reactions. As is seen in Table 3, it has the same capability of achieving less than 50 ppmv outlet CO<sub>2</sub> specification as the other formulations tested.

## GAS/SPEC CS-2000 Applications

Large volumes of coal seam gas are produced from the San Juan basin

in New Mexico and Colorado. This coal seam gas generally contains over 10 % CO<sub>2</sub> and virtually no H<sub>2</sub>S in a methane stream. The treating plants that have been put into operation on this gas are only required to remove the CO<sub>2</sub> down to 1 to 2% pipeline requirements but maximum throughput is emphasized. Many new or retrofit amine units have been placed in coal seam gas CO<sub>2</sub> removal service in recent years. <sup>4</sup> The first two GAS/SPEC CS-2000 applications were in coal seam gas appli-

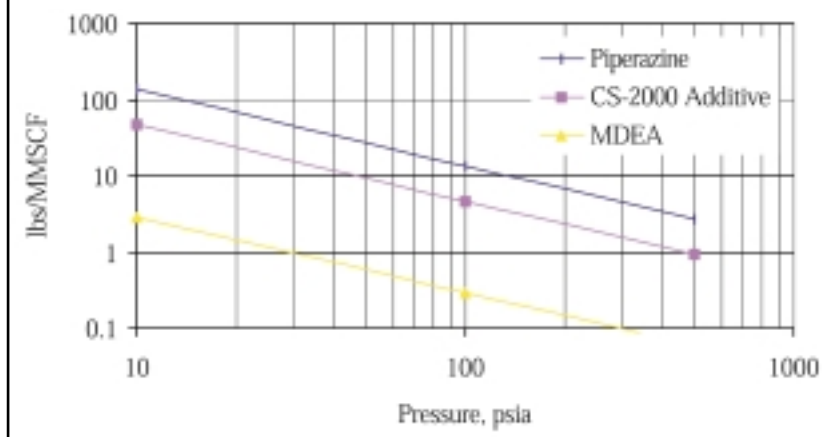
cations in retrofit amine units. The first of these went into operation on GAS/SPEC CS-2000 in mid-1998. There has been an overall increase of 15-30% above the designed capacity of the plant. Despite operating with high CO<sub>2</sub> loadings during the first 19 months of operation, the plant solution shows less than 50 ppmw of dissolved iron in the solution and a shutdown and inspection at that time revealed that very little corrosion had occurred.

Since that time, several refinery hydrogen units have been switched to GAS/SPEC CS-2000. In each case, the stability of the CS-2000 has been much greater than the previous MDEA based product used in the same facility. This has led to more consistent capacity throughput and reduced corrosion concerns. Inspection of an amine stripper after about a year of operation with GAS/SPEC CS-2000 showed virtually no fouling of the packing. This inspection is a marked contrast to previous inspections where iron carbonate fouling was so severe it had fused the packing together and had to be removed with a jackhammer.

Earlier this year, the first complete changeout of an ammonia plant to a GAS/SPEC CS-2000 product was completed. This plant is now

Figure 1

Comparison of Solvent Vaporization Losses for Piperazine and MDEA with GAS/SPEC CS-2000 Additive



# GAS/SPEC CS-2000



*Ammonia plant with standard amine system design.*

## **INEOS LLC**

*As part of a Federal Trade Commission mandated remedy to the merger of The Dow Chemical Company and the Union Carbide Corporation, INEOS plc was able to purchase both Dow's Ethanolamines (EOA) and GAS/SPEC\* MDEA-based Specialty Amines Businesses. This purchase became effective on February 12, 2001.*

*At the time, INEOS plc was the UK's second largest chemical company, with a group turnover of US\$ 3 billion and 6,000 employees, operating 35 facilities. The GAS/SPEC business was a good fit for INEOS because of its division focused on ethylene oxide (EO) and derivatives. Within its EO division, INEOS operates Europe's largest single EO/Glycol unit at the production site in Antwerp, Belgium.*

*INEOS LLC was set up as the newly acquired company, which includes the GAS/SPEC Technology Group. All the key Ethanolamines and GAS/SPEC personnel were retained by INEOS LLC. All INEOS LLC personnel are dedicated to supporting amine products, technologies and services, so the focus on gas treating needs has intensified.* ■

operating at 104% of capacity. A lower methanator temperature rise indicates even further reduction of CO<sub>2</sub> in the treated gas. Overall energy use is significantly below 50,000 BTU / lb-mol of CO<sub>2</sub> removed. This energy number is very good for a standard amine system containing 1 absorber and 1 regenerator, with no flash regeneration.

### Recent Developments

GAS/SPEC CS-2000 solvent has now been developed into an entire family of products. These products all have similar characteristics but are formulated to meet the needs of various applications. The products now available include GAS/SPEC CS-2010 and GAS/SPEC CS-2020. All

Table 3

Comparison of Deep CO<sub>2</sub> Removal Capabilities of other MDEA Formulations with GAS/SPEC CS-2000

Formulation	Outlet CO <sub>2</sub> capability
Formulation 1	~100ppmv
Formulation 2	<50
GAS/SPEC CS-2000	<50

of the CS-2000 series of products are currently being used in commercial amine units. The GAS/SPEC Technology Group provides products and services to hundreds of gas treating applications worldwide and a large number of these now operate on GAS/SPEC CS-2000 products. ■

### **REFERENCES**

1. For example, see: U.S. Patent No. 4,336,233 (1982).
2. For example, see: Hugo, R.S. "Revamp of Hot Potassium Carbonate CO<sub>2</sub> Removal Units to BASF's aMDEA® Process", *Proceedings of The AMMONIA ASIA '98 Conference, Singapore: June 23-24, 1998*. On p. 5, Hugo reports that the CO<sub>2</sub> loading capacity of lean aMDEA is about 4 lb-mol/m<sup>3</sup>. This compares to about 6 lb-mol/m<sup>3</sup> loading capacity of GAS/SPEC Product when each solvent is loaded to a rich loading of about 0.5mol/mol CO<sub>2</sub>.
3. *Properties of Aqueous Solutions of GAS/SPEC CS-2000 Specialty Amine*. Published March 1999, by The Dow Chemical Company.
4. For example, see T. H. Russell Company project listing at [www.thrco.com](http://www.thrco.com)

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