CCR Technologies Inc.
Technical Bulletin
Heat Stable Salt Terminology

Heat Stable Salts
Heat Stable Salts (HSS) have received a lot of attention in the industry. HSS are acid *anions* with a stronger acid strength than the acid gases that are removed from the process gas. These anions may bind to the usable amine and then therefore make it unavailable for acid gas absorption.

Heat Stable Amine Salts
Heat Stable Amine Salts (HSAS) refers to the salt formed by a HSS (anion) and a protonated amine molecule (cation). HSAS may also be referred to in some instances as Bound Amine (BA)

HSS ≠ HSAS
There has been much confusion about the terminology of HSS versus HSAS. It is important to understand that these HSS anions must be bound to a cation in solution so that the solution is balanced (Mother Nature's Rule). One must understand what cation forms a salt with the HSS anion to understand the disposition of the anions and their quantity in solution. As referred to earlier, the sum of cations in solution must equal the amount of anions in solution.

$$\Sigma \text{ Cations} = \Sigma \text{ Anions}$$

$$BA + SC = HSS + LL$$

BA = Bound Amine (Protonated Amine Molecule)
SC = Strong Cations (Sodium or Potassium)
HSS = Heat Stable Salt Anions
LL= Residual Lean Loading (H_2S or CO_2)

From the above equation we can see that HSS will not equal the Bound Amine (HSAS) if there is a substantial amount of Strong Cations present in the amine solution. This is why we recommend that the total level of HSS anions and Strong Cations should be measured directly. Measuring the HSAS only may give a false low reading of the level of HSS anions in solution if Strong Cations are also present in the sample.

HSS Reporting Terminology
It is important to understand that HSS anions may be reported at least three different ways, and it is important to understand the methodology employed to avoid confusion.

1. HSS – Weight Percent of Solution
   HSS Anions (Strong Acid Anions) measured as weight percent of the total solution.

2. HSS – As Weight Percent Amine
   This unit of measurement assumes that the HSS anions are bound to an amine cation (also reported as HSAS, Heat Stable Amine Salt). This number is determined by calculating the equivalent amount of amine cations that are tied up with the HSS anion, and is expressed as weight percent of the total solution.

3. HSS – As Percent Amine Capacity (As Percent Total Amine)
   HSS expressed as weight percent amine divided by the amine strength (Free Amine or Alkalinity).

Example Sample Analysis Form
Please see the attached example sample analysis form, which shows a bulk composition material balance and HSS anions listed the various ways.

DEA Customer			
Analytical Results			
Amine Type	DEA		**Alternate Units/Notes**
Amine Strength wt%	20.07		
Water wt%	72.00		
H2S wt%	0.00		
CO2 wt%	0.01		0.0014 m/m
Strong Acid Anions wt%	1.48		
Strong Cations wt%	0.07		
Bound Amine wt%	2.51		
Formamides wt%	0.27		
THEED wt%	0.60		
bis-HEP wt%	nd		
Bicine wt%	1.04		
Other wt%	na		
Percent Recovery	98.05		
Organic Acids			
Formate ppm	1247		
Acetate ppm	1451		
Oxalate ppm	609		
Lactate ppm	171		
Glycolate ppm	336		
Propionate ppm	nd		
Butyrate ppm	na		
Total ppm	3814		
Inorganic Acids			
Chloride ppm	21		
Sulfate ppm	113		
Sulfite ppm	nd		
Thiosulfate ppm	3910		
Thiocyanate ppm	6929		
Phosphate ppm	na		
Total ppm	10973		
Total HSS Anions ppm	14787		
Total HSS Anions wt%	1.48		Three different ways to express the value of the HSS Anions.
HSS as wt% Amine	2.77		
HSS as Percent Amine Capacity	13.79		
Example Report			
na = not analyzed			
nd = not detected			

Importance Of Water Content

While HSS anions (and to some extent strong base cations such as sodium or potassium) have received much industry attention due to their adverse affects on amine solvent quality, it is important to understand there are many other possible contaminants in an amine system. The accumulation of all of these degradation products does adversely affect the physical properties of the solvent. At constant amine strength, the accumulation of contaminants essentially "backs out" the corresponding percentage of water from the circulating solution. Water content probably has the greatest affect on the physical properties of the solvent.

Summary

It is important to understand the reporting terminology of HSS. This will help avoid confusion in discussions, and will allow for proper comparison to industry-recognized guidelines. See CCR Technical Bulletin "Solvent Quality Guidelines".

For more information or to inquire about a *complete* sample analysis contact CCR Technologies Inc. in Houston at 281-988-5800, or visit us at www.reclaim.com.

DEA Customer		
Residue Calculation		
Amine Strength wt%	20.07	
Water wt%	72.00	
H2S wt%	0.00	
CO2 wt%	0.01	Water, Active Amine, and Residual Lean Loading are the expected items in a healthy gas treating solvent.
Strong Acid Anions wt%	1.48	
Strong Cations wt%	0.07	
Bound Amine wt%	2.51	
Formamides wt%	0.27	
THEED wt%	0.60	
bis-HEP wt%	nd	
Bicine wt%	1.04	
Other wt%	na	
Un-Recovered	1.95	These remaining items in the solution are what we refer to as residue or the total contaminants in the system. These are the items that need to be controlled in the solution for optimal unit operation.
Total Residue	**7.92**	