InfoMine
research group

The association of independent consultants
in mineral resources, metallurgy and chemical industry in CIS

Ammonia
market research in the CIS
and forecast of its development in the financial crisis

4th Edition,
revised and supplemented

Sample PDF

MOSCOW
June, 2009

Internet: www.infomine.ru
e-mail: info@infomine.ru

CONTENTS

List of Tables

List of Figures

Summary

This report focuses on research of current conditions of the ammonia market in the CIS and forecast of its development. The report consists of 7 Sections, contains 177 pages, including 59 tables, 46 figures and 2 appendices.

Methodologically, the work was done in 2 stages: the "desk" research and the "field" activity. In the first phase multiple sources of information were analyzed, particularly data of state bodies - the Federal State Statistics Service (FSSS RF), State Statistics Committee of CIS countries, Federal Customs Service (FCS), the State Statistics Committee of Ukraine, the State Customs Service of Ukraine (SCSU), the state statistics of railway transportation of the Russian Federation. Also, data of companies, the database of "InfoMine", media materials and the Internet have beed used.

In the second stage the collected data were verified and refined through telephone interviews with specialists of the enterprises considered in this report.

The first chapter of the report gives a brief characteristic of the global market of ammonia and the forecast of its development.

The second chapter provides information on technologies used in the industrial production of ammonia, its main raw material (natural gas) and routes of its supplies in the CIS.

The third chapter of this review is devoted to the production of ammonia in the CIS. In particular, in this chapter, the characteristic of the current state of the main ammonia producers in the CIS countries is given.

The fourth and fifth chapters contain information about export-import operations with ammonia in the Russian Federation and Ukraine, and prices for this product.

The sixth part describes the market of the ammonia consumption in the Russian Federation and Ukraine. It analyzes in detail the structure of consumption of the chemical and the balance of "production-consumption." A review of the main branches of industry, consuming ammonia, is given, as well as the description of the largest enterprises-consumers of the product.

The seventh chapter of the report presents the forecast of development of the Russian market of ammonia for a period up to 2015.

The appendices present addresses and contact information of enterprises, producing ammonia in Russia and CIS countries, as well as addresses and contact information of the main Russian consumers of the product.

Introduction

Ammonia (NH_3) under normal conditions is a colorless gas almost twice lighter than air with a sharp characteristic odor. This scent is known to man since ancient times, as ammonia is produced in significant quantities at rotting, decay and dry distillation of nitrogenous organic compounds such as urea or protein. Solid ammonia is a colorless crystals with a cubic lattice.

The presence of hydrogen bonds along with the considerable polarity of the ammonia molecules causes a strong interaction between them, resulting in the physical properties of NH_3 in many respects anomalous compared to the similar compounds (PH_3, SbH_3, AsH_3). For example, the closest analogue of ammonia - Phosphine PH_3 - has boiling temperature of 87,4°C (NH_3 has -33,35ºC) and melting temperature of - 133,8°C (NH_3 has -77,7ºC), despite the fact that PH_3 molecule is twice as heavy as the NH_3 molecule. However, the strength of hydrogen bonds in liquid ammonia is considerably lower than that of water, so its viscosity is 7 times less than the viscosity of water (for water at 20°C, η = 1 mPa s).

The interaction of ammonia with water occurs by the donor-acceptor mechanism. In this case, the solubility of NH_3 decreases with the temperature increasing. So, at 0°C 100 g of water dissolves 42.8 g of ammonia, at 20°C just 33.1 g, at 60°C - only 14.1 g. The density of ammonia solutions changes similarly with the increasing content of ammonia. The density of 8% solution of NH_3 is 0.970 g/cm^3, that of 32% solution is 0.889 g/cm^3, that of 75% solution is 0.832 g/cm^3. In addition, ammonia is readily soluble in alcohol, acetone, chloroform, benzene and other organic solvents.

Ammonia can be called a very reactive compound. Its typical reactions are the addition reactions, in particular the addition of the proton at interaction with acids. Such reactions yield salts of ammonia (NH_4^+), which in many properties are similar to the salts of alkali metals. As a Lewis base, ammonia attaches not only to H^+, but to other electron acceptors as well. Reactions of ammonia with salts yield ammines (coordination compounds containing one or more NH_3 molecules as ligands). Alkali and alkaline-earth metals react with the liquid and gaseous ammonia with the formation of amides. Heating many metals and non-metals (Zn, Cd, Fe, Cr, B, Si, etc.) in an ammonia atmosphere yields nitrides. Liquid ammonia reacts with sulfur with the formation of hydrogen sulfide and N_4S_4. At about 1000°C NH_3 reacts with carbon, forming hydrocyanic acid and decomposing into gaseous nitrogen and hydrogen.

Decomposition of ammonia into hydrogen and nitrogen becomes noticeable at temperatures above 1300°C; in the presence of catalysts, the decomposition temperature is lowered to 400°C. Gaseous ammonia forms explosive mixtures with air.

Ammonia is toxic, it contaminates water reservoirs in contact with them. Maximum permissible concentrations (MPC) in air of populated areas are as follows: the daily average and maximum one-time is 0.2 mg/m^3; the maximum allowable in the operating room of an industrial enterprise is 20 mg/m^3. Its odor is felt at a

concentration of 40 mg/m^3. If the air content of ammonia is 500 mg/m^3, it is dangerous to inhale (it can be fatal). Ammonia stronly irritates the mucous membranes. Liquid ammonia causes severe skin burns. In acute poisoning the eyes and the respiratory tract are affected. Chronic poisoning causes the indigestion, catarrh of the upper respiratory tract, the hearing impaired. Given the above, the synthesis of ammonia is classified as hazardous. For the safe operation of the equipment it is important to have uninterrupted power supply, perform all work in strict accordance with the regulations, as well as to carry out diagnostic measurements and timely repairs.

Industrial filtration and insulating masks and gas masks provide respiratory protection from ammonia. For these purposes the following industrial gas masks can be used: KD (the box is colored in gray), K (light green), and respirators RPG-67-KD, RU-60M-KD.

The maximum allowable concentration when using industrial filter masks is 750 MPC (15000 mg/m^3), above which only insulating gas masks must be used. For respirators, the dose is 15 MPC. With the emergency response on accidents on chemically dangerous objects, when the concentration of ammonia is unknown, the work must be carried out only in insulating gas masks.

In terms of output volumes ammonia is on one of the first places in the chemical industry. Ammonia is produced in liquid form or in aqueous solution - ammonia water, which usually contains 25% of NH_3.

The main use of ammonia is the production of ammonia fertilizers - mainly nitrogenous (urea, nitrate and ammonium sulfate) and phosphate ones (ammophos, diammofosa). Ammonia water is also used as a fertilizer. Moreover, in some cases, the field is poured directly from the tank with liquid ammonia. Ammonia is also used to produce nitric acid, caprolactam, sodium carbonate (as an ammonia method), and to a lesser extent, nitrogen-containing salts and hydrogen cyanide. In addition, ammonia is a good solvent for the majority of nitrogen compounds.

In addition to the chemical industry NH_3 is used in the light industry for cleaning and dyeing cotton, wool and silk. In the petrochemical industry the chemical is used to neutralize acidic wastes, and in the production of natural rubber ammonia helps to preserve latex in the process of its transportation from the plantation to the factory. In the steel industry NH_3 is used to create protective environments (nitriding is the saturation of the surface layers of steel with nitrogen, which greatly increases its hardness). In cryogenics ammonia is employed as a refrigerant. Physicians use aqueous ammonia in daily practice: the cotton wool soaked in ammonia forces a person from an unconscious condition.

I. World Ammonia Market

I.1. Ammonia manufacturing capacity, projects on the production increase

The worldwide production capacity for ammonia in 2008 was approximately 180 million tonnes, higher than in 2007 (176 million tons) by 0,6%. The main increase in capacity over the past three years is attributed to China, Africa, West Asia and Lithuania.

To date, about 60 countries produce ammonia, and as a result, the import share of world consumption of ammonia is relatively low (about 13%). Nevertheless, it is worth noting that the world trade in ammonia in the pre-crisis period showed an upward trend, as the high cost of natural gas in the developed world contributed to the transfer of production facilities to regions with low energy prices. Untill 60-70's the main output of ammonia and nitrogen fertilizers fell on to Europe and North America, however, later the production was moved to gas-rich areas of the Middle East and the Caribbean. Now, leaders in the production of ammonia are the largest consumers of the product - China and India, and also Indonesia, Pakistan.

The nitrogen fertilizer industry of North America experienced a serious shock due to the rising prices for gas and electricity in the 70's and 80's: a large proportion of production was shut down or moved to other countries. Now capacities of the American ammonia manufacturers are in the order of 16 million tons, more than 70% of which fell on four leaders of the sector: Agrium, CF Industries, Koch and Terra. However, for these companies as well a large proportion of production comes from the foreign factories. Thus, Koch Nitrogen (Corporation Koch International) produces ammonia in Venezuela and Trinidad and Tobago, Agrium has the production facilities in the Caribbean, U.S. and UK. Capacities for the production of ammonia and nitrogen fertilizers of the world's largest manufacturer of mineral fertilizers Potash Corporation are concentrated in the southern states of the USA and Trinidad.

Three of the world’s largest manufacturers of ammonia and nitric fertilizers are Norwegian Yara, American Terra and Canadian Potash Corp.

The main stimulus to increased production of ammonia during the last 5 years is the favorable ammonia market conditions and the possibility of lucrative export sales. In 2005-2008, following the growing demand for this product, primarily from the manufacturers of fertilizers, which use more than 75% of the world's ammonia, many companies were actively building up their prodution capacities. Thus, in 2006, the world's capacities increased by 6 million tons. New export-oriented capacities were built in Australia, Trinidad and Tobago, Saudi Arabia and Oman. In addition, in 2006 the ammonia production started in Lithuania, which can produce 1,5 thousand tons per day (550 thousand tons per year). Currently the construction of a new ammonia production with the capacity of 660 thousand tons is close to completion in Egypt (EBIC), a factory with the annual production capacity of ammonia of 360 thousand tons is under construction in Iran (NPC). In 2009 the world production of NH_3 is planned to expand by introduction of factories with the capacities of 1,5 million tons in Trinidad and Tobago, 1,1 million tons in Algeria, 365 thousand tons (Guizhou Tianfu Chemical) and 450 thousand tons (PetroChina) in China. In 2010

the construction of the ammonia factory with the production of 350 thousand tons per year is planned in Qatar (Qafco). In Venezuela, there are plans to launch several new ammonia/urea complexes after 2010, which will produce a certain amount of ammonia. For 2012-2013 there are plans to build in the U.S. a new large single ammonia production capacity of 1.3 million tons per year in Faustina (Louisiana).

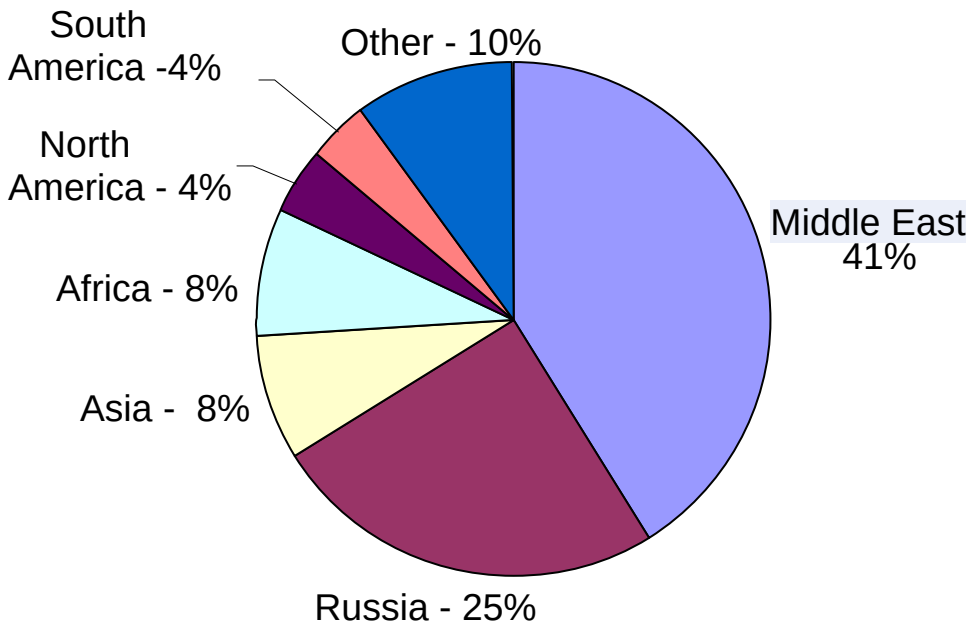
If planned projects are realized, the total world ammonia capacity by 2013 will increase to 214 million tons. Of this increase 25 million tons are due to construction of new plants and 9 million tonnes are due to expanding the existing facilities. The bulk of this increase will be processed into urea, and the rest will be issued in the form of ammonia. However, amid the global economic crisis it is likely that some of these projects will be postponed because of high capital costs, a shortage of building materials or problems with the supply of natural gas and product sales. In general, deployment of new ammonia facilities will be determined by several factors: the regional cost of raw materials, the government policies to support a more advanced processing of hydrocarbon raw materials, the modernization of production in order to save the energy, and in the longer term by the projected demand.

I.2. Cost and volumes of world ammonia production

For most ammonia producing enterprises, the main raw material is natural gas. About two-thirds of the world's capacities use gas as a raw material. In the second place stands coal, its share is 27%, and the remaining 6% comes from naphtha and petroleum products (fuel oil). The bulk of coal-based capacity is located in China. India is a major consumer of naphtha in the production of ammonia. However, in recent years due to transition of plants to natural gas and coal, the share of naphtha and fuel oil is reduced.

Because natural gas is the main raw material for the production of ammonia, production plants are located near the major gas producing regions, and the cost of ammonia production depends on the natural gas consumption per ton of production. The distribution of world's gas reserves by regions in 2008 is presented in Figure 1.

Figure 1: Regional structure of world natural gas reserves as of 2008, %



Source: BIKI (БИКИ), №13, 2009.

Depending on technology, 800-1300 m^3 of gas is required to produce 1 ton of ammonia. Given the above, the cost of ammonia in the gas producing countries is much lower compared to other manufacturers.

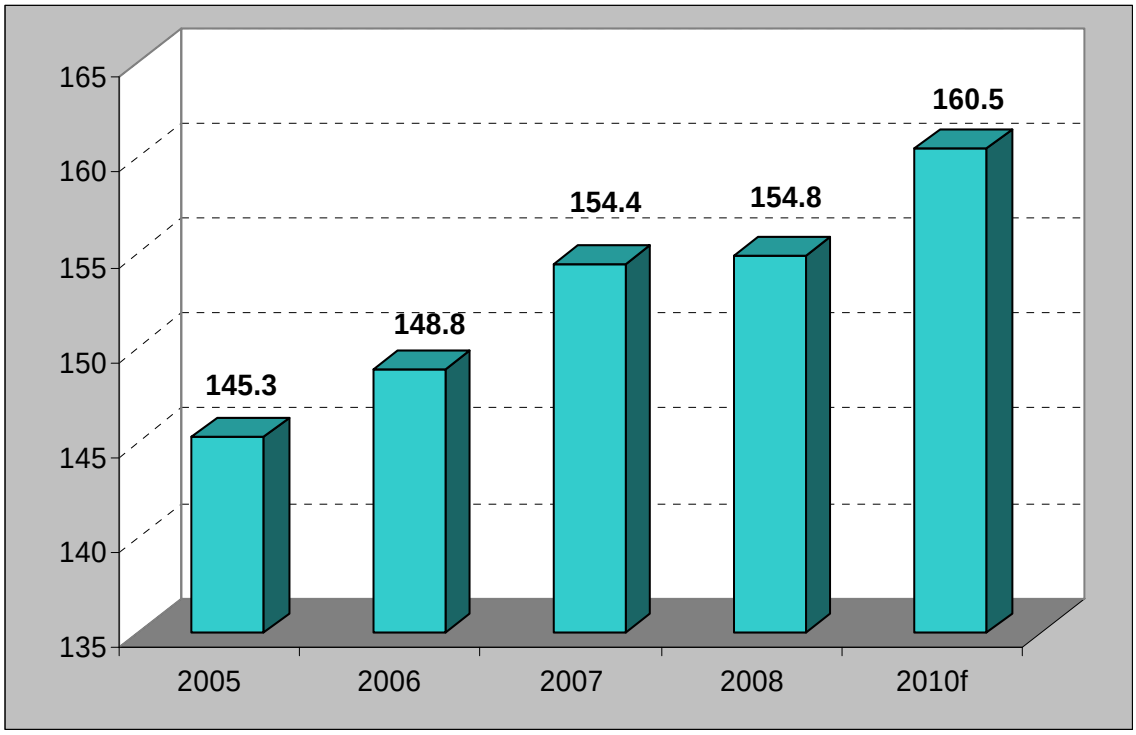
Thus, in 2006-2008, the lowest cost of production was in the Middle East, Venezuela, Argentina, Australia, Russia (on average 100-120 $ / ton), the largest - in the U.S., Western Europe (220-450 $ / ton).

High natural gas prices in the developed countries make manufacturers from the U.S. and EU the marginal (price-determining) producers of the nitrogen industry. At cost of natural gas of 250$ for 1 thousand $м^3$ (which approximately corresponds to the average gas price in the spot market in the U.S. in 2006) the costs of basic raw materials for U.S. manufacturers account for about 90% of the cost of ammonia production. Thus, the dynamics of the gas prices determines the cost dynamics for

producers in the developed world, supporting world prices for nitrogen products. At the same time, considering a significant amount of the frozen ammonia production capacities in the U.S. and EU, a significant rise in prices for nitrogen products, compared with production costs in Western countries, is also unlikely, as in this case the frozen facilities will be reopened, which will result in the reduction of the world price.

The world production of ammonia is about 155 million tons. Over the past 4-5 years the production volumes have increased significantly. Thus, in 2005 the world production of ammonia amounted to 145.3 million tons (Figure 2), and by 2008 it has reached 154.8 million tons (an increase of 6,1%).

Figure 2: The volume of world production of ammonia in 2005-2008 and forecast for 2010, million tons



Source: estimate by InfoMine based on the UN database

The most significant increase took place in China, Egypt, Saudi Arabia, Lithuania and the U.S. The production in Canada, India, Vietnam and Poland was reduced.

The average capacity utilization in the world production of ammonia in 2007-2008 was about 86-88%.

Given that the access to cheap natural gas is a key factor in determining the competitiveness of nitrogen products, the world's major manufacturers and suppliers of ammonia are two regions with the lowest total cost of these raw materials - Eastern Europe (especially Russia) and the Middle East. Trinidad and Tobago, located in the Caribbean, is also a large producer of ammonia, and in recent years many American factories have started to export semi-finished products from that country, which possesses significant reserves of gas.

To date, the world's largest producer of ammonia is China (about 50 million tons per year). In India, the production of ammonia in the past five years was consistently about 12 million tonnes per year. The annual ammonia production in the U.S. stands at 10 million tons per year. The share of Russia in 2008 accounted for more than 8% (12,7 million tons) of world's production of ammonia.

Generally, the world's leading producers of nitrogen fertilizers can be divided into 3 types of companies:

• oil and gas companies, for which the business of producing nitrogen fertilizers is collateral: Sinopec (China), SABIC (Saudi Arabia), PetroChina (China);

• diversified fertilizer producers: Agrium (Canada), Potash Corp. (China), CF Industries, EuroChem (Russia);

• companies, specializing in the nitrogen industry: Yara (Norway), Terra Nitrogen (U.S.), Togliatti (Russia).

Major companies that produce ammonia for their own production of fertilizers, are also BASF AG (Germany), Ineos (UK), Kemira GrowHow Oy (Finland), Mitsubishi Chemical (Japan), Mitsui Chemical (Japan), Showa Denko (Japan), etc.