Competing in a changing world: A comparison between DSM and Solvay in the chemical industry, 1970-2010

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Abstract (194 words)

Throughout the twentieth century the chemical industry has changed profoundly in its competitive makeup and geographical spread. In this paper we draw comparisons between two multinational chemical companies, DSM and Solvay, and focus on two bulk chemicals, ammonia and soda ash respectively. At the group level, both DSM and Solvay have been successful companies but the strategies they pursued in bulk chemicals were very different. DSM exported ammonia fertilizers all over the globe until 1970 but competition from Asia and the oil states have confined the large plants to mainly supplying the agricultural market within a radius of ca. 400 km. Solvay, by contrast, selectively invested in its soda ash plants located near sea ports, and is still exporting its products globally. Comparing Solvay and DSM begs the question how this happened and why, and ultimately how one company survived with bulk chemicals and the other without. We analyze markets, technologies, feedstocks and strategy to answer these questions. We argue that control over feedstock and technology is crucial. In addition, the large but slowly growing markets with their cycles of boom and bust require commitment; business strategy, in other words, plays a crucial role.

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An economist looking at the European petrochemical industry in the early 1990s, concluded that the sector was coping with a "mid-life crisis": it was stuck with modest growth, and modest prospects; its best days were behind it.[1] Indeed, the European chemical industry has changed profoundly since 1970 with new entrants growing quickly and established companies changing face completely. Particularly bulk chemical products, produced in large quantities and sold on the basis of their chemical composition, have been subject to fundamental change and profound shifts in the geographical focus on production. In this paper, we focus on two companies, Solvay from Belgium and DSM from the Netherlands, and two bulk chemicals, soda ash and ammonia respectively, and analyze how these companies coped with these changes. The headquarters, as well as the origins, of both companies are situated in two small, neighboring countries, with strongly export oriented economies. It is therefore interesting to investigate the regional dynamics of these two rather similar cases under the influence of recent global forces.

A long tradition of scholarship focuses on growth, competitiveness and catch-up of nations; recently regions and industries have also attracted substantial attention.[2] In addition, life cycle models of technologies, firms and industries typically include a phase of maturation and decline that appears simply an inevitable and automatic consequence of the progression of time; at some point in time a technology is born and, as fact of life, at some point it dies.[3] For chemicals, several studies have described the competitive and geographic shift from Western Europe, the United States and Japan to the Middle East and Asia.[4] In addition, several industry-level studies have drawn conclusions on the generic drivers of change.[5] The picture that emerges

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[1] Willem Molle (1993). Oil refineris and petrochemical industries: Coping with the mid-life crisis. Henk W. de Jong, Ed. *The structure of the European industry.* Dordrecht: Kluwer Academic Publishers, 43-63: 43, 61-62.

[2] For instance: Moses Abramovitz (1986). Catching up, forging ahead, and falling behind. *Journal of Economic History* 46(2), 385-406. Terutomo Ozawa (2011). The (Japan-born) 'Flying-Geese' theory of economic development revisited - and reformulated from a structuralist perspective. *Global Policy* 2(3), 272-285.

[3] Angela M. O'Rand & Margaret L. Krecker (1990). Concepts of the life-cycle: Their history, meanings, and uses in the social sciences. *Annual Review of Sociology* 16(1), 241-262.

[4] Keith Chapman (1991). *The international petrochemical industry: Evolution and location.* Oxford: Blackwell.

[5] Peter H. Spitz, Ed. (2003). The chemical industry at the millennium: Maturity, restructuring, and globalization. Philadelphia: Chemical Heritage Press. Louis Galambos, Takashi Hikino & Vera Zamagni, Eds. (2007). *The global chemical industry in the age of the petrochemical revolution.* Cambridge: Cambridge University Press.

from these studies is rather bleak; Western chemical companies have sought their business elsewhere, outside the bulk chemicals sectors or have performed poorly. For instance, a study on Norsk Hydro, the Norwegian chemicals, metals and energy company, argues that the expansion of its fertilizer division after 1978, so in the face of tough competition, failed to pay off; Norsk Hydro struggled to make a profit (at the level it thought necessary) and the results for shareholders were disappointing. This study argues that Norsk Hydro reacted too late to the shifting competitive fabric of the industry and, ultimately, made the wrong decision to expand.[6]

We nuance the macro-level story of maturation and decline by providing case studies of two chemical firms, DSM from the Netherlands and Solvay from Belgium, and of two products, ammonia and soda ash respectively. In a nutshell, Solvay and DSM, and the strategies they pursued, can be considered two extremes of a spectrum of possible strategies firms deployed to cope with the profound shifts in (the chemical) industry since 1970. Solvay was a first mover in soda ash in the late nineteenth century and has maintained its leading position up till this day. DSM was a late mover in ammonia and gradually retreated after 1970, culminating in the sale of the fertilizer division in 2010.

Studying DSM and Solvay, in other words, provides us with an example of a firm that seems to conform to the general macro-level picture, and one that does not. In this paper, we ask how this was possible and why this happened. We focus our analysis on three key dimensions in bulk chemicals: technologies, feedstocks and markets. In this perspective, keeping control of technology and feedstock is crucial but often difficult. An extensive market for ammonia technology developed early in the twentieth century, enabling DSM to enter fertilizers in 1930 but also the oil states forty years later. The switch from coal-based to hydrocarbon feedstock also meant a loss of control of feedstocks for DSM. Solvay was able to maintain its technological leadership and was vertically integrated, keeping tight control over feedstocks.

This paper is a comparative history of important divisions within two chemical companies, put in the overall frame of the strategies these companies pursued. Most studies on the history of the chemical industry focus on the industry as a whole or only one company. Although most studies do attempt to put their case into the context of the industry, some single case studies do not even attempt to generalize beyond that specific case.[7] Single case studies are also notoriously hard to generalize, particularly in such a diverse and complex industry such as chemicals.[8] Simply doing more case studies does not solve this issue and runs the risk of blurring into an industry-level study.[9] Undisguised industry-level studies often take a thematic approach

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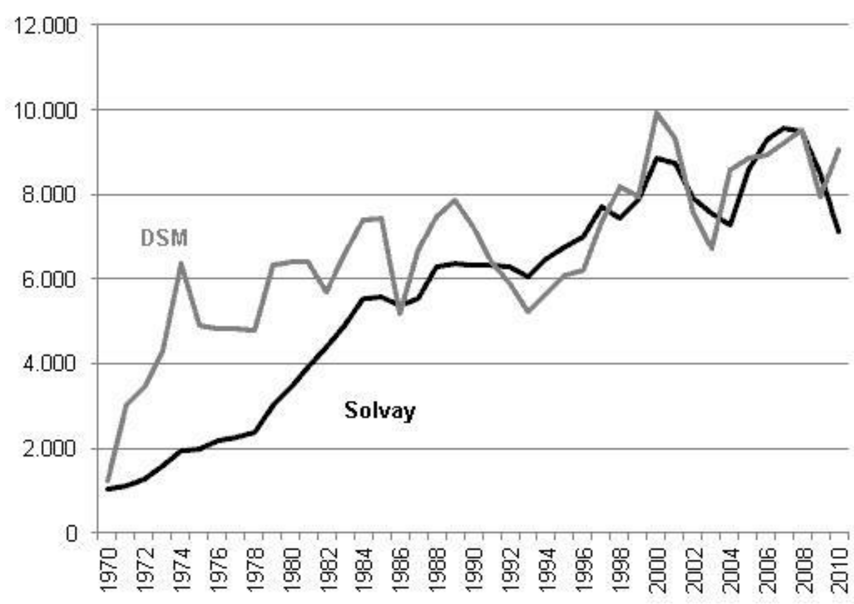
[6] Einar Lie (2008). Market power and market failure: The decline of the European fertilizer industry and the expansion of Norsk Hydro. *Enterprise and Society* 9(1), 70-95.
[7] Particularly books. See, for instance, the excellent study of BASF that is only about BASF: Werner Abelshauser, Ed. *Die BASF: eine Unternehmensgeschichte.* München: Beck.
[8] See for instance the history of the R&D labs: Ernst Homburg (1992). The emergence of research laboratories in the dyestuffs industry. *British Journal for the History of Science* 25(1), 91-111.
[9] Alfred D. Chandler (2005). *Shaping the industrial century. The remarkable story of the modern chemical and pharmaceutical industries.* Cambridge, MA: Harvard University Press.

and focus on countries and, consequently, say less about firms and their strategies.[10] In this paper we focus on the firm-level and analyze companies and products that are comparable yet displayed a different outcome. In this way, we may not only learn how firms responded to the changing challenges after 1970 (as would be the case in a single case study); we may also learn what is decisive in shaping that response.[11]

Consequently, we selected two comparable products: ammonia and soda ash are both so-called bulk chemicals that are manufactured in high volumes and sold on the basis of their composition. We also selected two comparable companies. The ownership structure of these two firms was special, DSM being a fully state-owned firm until 1989 and Solvay being run by (descendents of) the Solvay family, but the two firms are comparable in size and position in the chemical industry. Moreover, both firms emerged with two neighboring, export-oriented countries; so they share the same regional basis. Both companies were substantial by 1970 and continued to grow over the period under study here, although DSM grew more quickly in the 1970s (Figure 1). Compared to industry leaders, however, both companies were mid-sized.[12]

This paper proceeds as follows. First, we outline our analytical framework to explain competition in bulk chemicals. Subsequently, we sketch the history of Solvay and DSM before 1970 and sketch the generic drivers of change in the chemical industry of the 1970s. The next two sections analyze DSM and Solvay after 1970.

Figure 1: Sales of Solvay and DSM – compared (in million €)



[10] Spitz 2003; Galambos et al. 2007.
[11] Inspired by: John Gerring (2007). *Case study research: Principles and practices.* Cambridge: Cambridge University Press.
[12] E.g. *ICIS Top 100 Chemical Companies* (2011). ICIS Chemical Business, 10-16 September 2011.

Notes:	Sales figures are corrected for inflation. DSM sales exclude energy sales until 1987; that year, DSM de-consolidated its energy-related activities. The drop in sales for Solvay in 2010 is due to the divestment of its pharmaceutical business; in 2011 it bought Rhodia.
Sources:	DSM: annual reports 1970-2012. Solvay: Kenneth Bertrams, Nicolas Coupain & Ernst Homburg (2013). *Solvay: History of a multinational family firm.* Cambridge: Cambridge University Press. 570-572.

1. Understanding the dynamics of bulk chemicals

Figure 2: The diversity of the chemical industry

		Type of product	
		Specification	Performance
Production	Large volume	Bulk chemicals	Pseudo commodities
	Small volume	Fine chemicals	Specialty chemicals

Adapted from: Charles H. Kline (1976). Maximising profits in chemicals. *Chemtech* 6(February 1976), 110-117.

The chemical industry is a heterogeneous industry; Figure 2 tries to capture this diversity in two dimensions: the scale of the production technology, and the types of products.[13] High volume production is very different from low volume production in the chemical industry. Big plants typically make only one product. These so-called dedicated plants require large capital outlays and economies of scale play a crucial role; building a bigger plant may often turn out to be relatively cheaper and may often lead to lower production costs.

In addition, two types of products may be distinguished. So-called specification products are sold because of their specific chemical composition. Fertilizers, for instance, contain plant nutrients (nitrogen, phosphate or potash, separately or in combination); this content can be easily tested, and on the basis of this content they are sold. In the case of these products, firms typically compete on cost price. By contrast, so-called performance products are sold because of their product characteristics. Plastics, for instance, come in many very different shapes and sizes; specific characteristics may make a particular type of plastic particularly suited for some applications but not for others; producers have to analyze which kind of applications could work and which applications could make most money, necessitating ample knowledge of applications if not close connections to customers.

[13] This typology was originally developed by: Charles H. Kline (1976). Maximising profits in chemicals. *Chemtech* 6(February 1976), 110-117. Later additions include: J.A. Bigot (1980). Heden en toekomst van de Nederlandse fijnchemie. *Chemisch Magazine* (November 1980), m 729-m 732. A. Boccone (2003). Specialty chemicals. P. H. Spitz, Ed. *The chemical industry at the millennium: Maturity, restructuring, and globalization.* Philadelphia: Chemical Heritage Press, 85-110.

In our framework, three factors are crucial in understanding bulk chemicals: technologies, feedstocks, and markets.[14] To be competitive in bulk chemicals, companies often find themselves in need to build the largest plant technologically possible (at a particular point in time). In these big, dedicated plants, process technology and innovation are crucial. For several bulk chemicals, however, markets for technology have developed over the course of the twentieth century. Production firms often licensed technology to other production firms; markets are typically too large to monopolize and other sources of technology are typically available as well. In addition, engineering contractors played a crucial role; these firms specialized in the engineering and construction of plants, working with technology from production companies or developing their own processes. Through markets for technology, the latest technology in bulk chemical often diffused rapidly.[15]

Cheap feedstocks are also crucial in the manufacture of bulk chemicals. The plants are large, requiring large volumes of feedstock, and are typically very energy-intensive as well. This makes bulk chemicals manufacture often very attractive for companies (or countries) seeking to upgrade their feedstocks. Vice versa, backward integration into feedstocks can be a key advantage for production companies. An important part of the history of bulk chemicals in the twentieth century has been this forward and backward integration to upgrade or secure feedstocks.

Finally, the markets for bulk chemicals are typically very competitive and often cyclical. Bulk chemicals are specification products; companies have little means to distinguish their products from the products of competitors. Price often plays a decisive role. The big plants, moreover, often produce much more than the home market can absorb, making firms dependent on exports. The big plants also got bigger again and again, particularly in the 1960s, leading to a distinctive boom and bust cycle.[16] Expansion came in large increments only and, as markets no longer grew at a corresponding speed, building a plant typically added more capacity than the market needed. Postponing investment, however, often also seemed unattractive as many companies were active in bulk chemicals; waiting held serious risk of losing market share. So most companies decided to build, sending the industry downwards until demand again caught up with supply. This boom and bust pattern has also been an important driver of concentration in bulk chemicals; postponing plant investment becomes easier with fewer competitors.[17]

2. First movers and late movers: Solvay and DSM in soda ash and ammonia

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[14] Other "bulk" products may have similar characteristics, for steel see: Jonathan Aylen (1982). Plant size and efficiency in the steel industry: An international comparison. *National Institute Economic Review* 100, 65-76.

[15] Cf. Arjan van Rooij (2004). *Building plants: Markets for technology and internal capabilities in DSM's fertiliser business, 1925-1970.* Amsterdam: Aksant

[16] Peter H. Spitz (1988) Petrochemicals: The rise of an industry. New York: John Wiley & Sons. 418-461.

[17] J. Roberts (2003). The financial community takes charge. P. H. Spitz, Ed. The chemical Industry at the millennium: Maturity, restructuring, and globalization. Philadelphia: Chemical Heritage Press, 283-310: 305-310.

Solvay: The man, the technology, and the expansion of the business[18]

Soda ash -- used many in the glass, soap and steel industries -- was produced industrially on a massive scale already for decades by the so-called Leblanc process, when the young Belgian self-made chemist Ernest Solvay (1838-1922) patented another process, that produced less waste and that was potentially more economic. Together with his brother Alfred and his friend Louis Acheroy they started developing this so-called ammonia-soda process at an industrial scale. With the help of their family and of local entrepreneurs they set the partnership Solvay & Cie. at Couillet, Belgium, in December 1863. Situated at the heart of the industrial region around Charleroi, with its many glass-making firms, and close to coal-mines and limestone quarries (two of the three crucial raw materials, next to salt), the Couillet plant was built at a good location. By that time, the Solvay brothers had discovered that their process was not new at all. It had been patented before, and others had tried unsuccessfully to develop the process on a large scale. The first few years of the company were very difficult therefore, but Ernest and Alfred Solvay and their co-workers succeeded in finding several smaller and larger technical improvements, that were all patented, so that by the end of the 1860s for the first time a small profit could be noted.

From then on the business expanded quickly. As soon as all the technical difficulties had been overcome, it appeared that the Solvay company could produce soda-ash at a cost price that was below the competing Leblanc products. As a result, demand grew quickly, and profits grew accordingly every year. They were reinvested in the expansion of the business. The second pillar under the company's success was patenting. One of the silent partners in the firm, Eudore Pirmez, was a lawyer, and was very good in formulating the patents of the firm, and submitted them in almost every important industrial country in Europe and North-America. In 1872, Ernest Solvay was contacted by Ludwig Mond, a German chemist with a strong experience in the British soda ash industry, who asked for licenses on Solvay's British patents. After an agreement was reached, the company Brunner and Mond was founded, a plant was constructed at Northwich in 1873. Solvay received a fixed fee of eight shillings for every ton of soda ash produced. The quickly expanding British soda ash business soon became an enormous cash-cow for Solvay. Mond also appeared to be a technical genius, and he contributed significantly to the improvement of the Solvay process. There improvements were also introduced in other plants of the Solvay group that would soon be constructed.

The first of these was a large plant at Dombasle, near Nancy in France, constructed in 1873, parallel to the plant at Northwich. One of the disadvantages of the original plant at Couillet was that rock salt was not found locally, it had to be transported to the plant. In the early 1870s Solvay therefore searched for locations in northern France where salt deposits, coal mines and lime stone quarries would all be present. Dombasle was such a place. In view of the far larger French market, as compared to Belgium, a big plant was constructed that included all the improvements developed at Couillet, as well as by Ludwig Mond. It would become the 'model plant' of the group.

With plants in Belgium, France and Britain, by 1880 large earnings were coming in uninterruptedly. Often together with local partners, Solvay & Cie. started a process of international expansion, protected by a network of local patents, and by only selecting sites where all three feedstocks (salt, limestone, coal) were available. In 1880 the company started its first plant in Germany, in 1881 in both Russia and the USA, and in 1883 in Austria, Before the First World War also subsidiaries and plants were established in Rumania, Poland, Bohemia, Spain, Bosnia and Italy.

In order to coordinate that network a third pillar under Solvay expansion was constructed: a system of technical reporting, started in a modest way in 1875, and perfected during the 1880s, when also a central technical department was established inside the Brussels headquarters of the Group. In this way the technical efficiency of plants was monitored on a monthly basis, and the improvements and 'best practices' of one plant were communicated to the others. With this system of centralized communication within the Solvay Group, and utmost secrecy towards outsiders, Solvay succeeded in reaching a global technical supremacy in the field of soda ash technology.

This technical supremacy was complemented by a careful commercial strategy with two key ingredients: the conclusion of cartel agreements with almost all the major competitors, and a price setting of soda ash with a sales price just below the commercial price of Leblanc producers, despite that fact that Solvay's cost price was far lower. In that way it was avoided that the Leblanc producers would panic, and try to imitate the Solvay process. They were killed slowly, but steadily, while Solvay was gaining huge profits at the same time. By 1886 the world production by the Solvay process about equaled the production by the Leblanc process, and by about 1920 the last Leblanc soda ash plant closed its doors. (Figure 3)

The Solvay Group implemented a policy of utmost secrecy in all technical matter, in order to protect its global technical and commercial monopoly. But in the course of time a few 'leaks' emerged through which technical details started to circulate in the outside world. The first of these was the United States, where labor contracts were less rigid than in Europe. Technical experts and workmen of the Solvay Process Company at Syracuse left the company and started working for competitors, such as the Mathieson Alkali Works, founded in 1892, and the Michigan Alkali Co. starting in 1894. Between 1892 and 1910 five large ammonia-soda plants were established in the United States. The second leak was Soviet Russia, that nationalized the three Russian plants of the Solvay Group after 1917. The third major leak, finally, was the Eastern European side or

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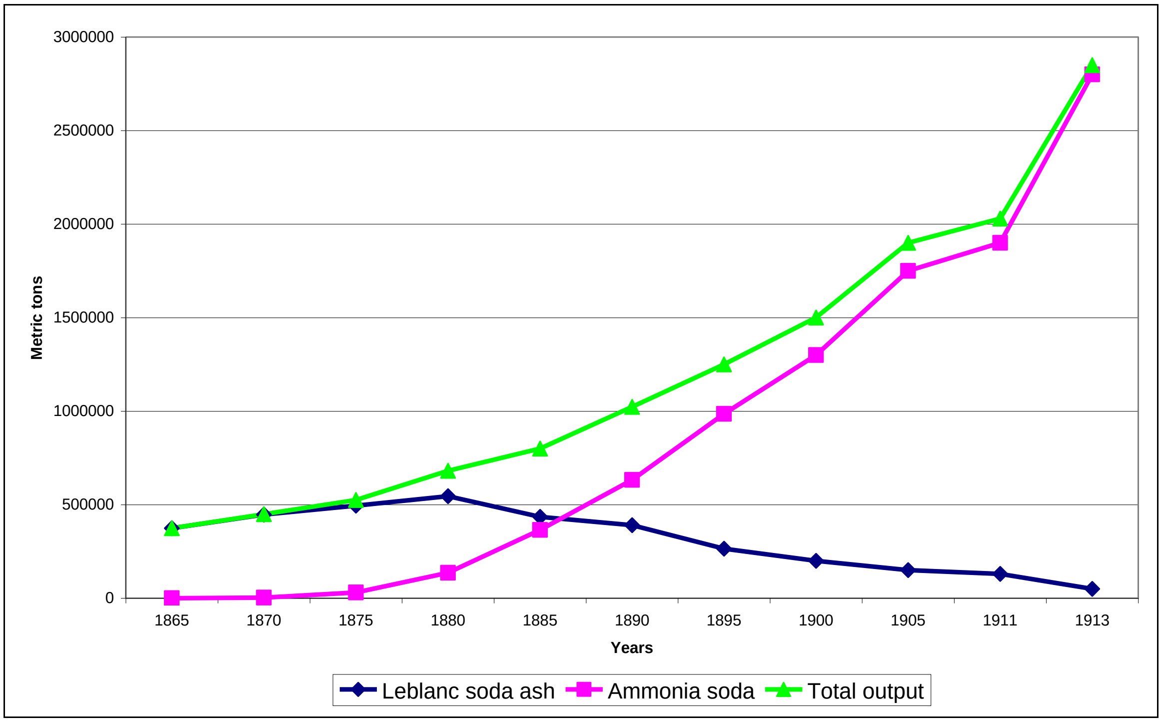
[18] This section is based on: Nicolas Coupain, 'The pioneering years (1863-1914): The quest for leadership and the first stages of the internalization,' pp. 7-147 in: Kenneth Bertrams, Nicolas Coupain & Ernst

the iron curtain, where after 1945 almost ten soda ash plants were nationalized by the regimes of the GDR, Poland, Rumania, Czechoslovakia and Yugoslavia. As a result, important technical publications, such as Te-Pang Hou's, *Manufacture of soda. With Special Reference to the Ammonia Process* (1947), based on the US soda ash industry, and Zoran Rant's, *Die Erzeugung von Soda nach dem Solvay-Verfahren: eine verfahrenstechnische Darstellung* (1968), based on Solvay's former plant in Bosnia, informed the public domain.

In this way Solvay's leading position gradually eroded, but the company responded by a permanent top-level engineering effort to find and implement improvements on a continuous basis.

Figure 3: Worldwide soda ash production (1865-1913)



Source: Te-Pang Hou, Manufacture of soda. With Special Reference to the Ammonia Process, New York, 1947, p. 41. (copied from Kenneth Bertrams, Nicolas Coupain & Ernst Homburg (2013). *Solvay: History of a multinational family firm.* Cambridge: Cambridge University Press, p. 68)

DSM: From mining to fertilizers and chemicals 1920s

In 1913, the German chemical company BASF took the first industrial ammonia synthesis plant on stream. Synthesizing ammonia from its elements, hydrogen and nitrogen, at high pressure, high temperature and with a catalytic process, was a tremendous breakthrough. Synthesis of ammonia allowed large-scale production of nitrogen fertilizers which, in turn, was essential in

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Homburg (2013). *Solvay: History of a multinational family firm.* Cambridge: Cambridge University Press.

boosting the productivity of agriculture. In addition, ammonia opened a path to the production of explosives and munitions.[19] BASF ultimately failed to monopolize ammonia synthesis technology (although it surely tried); the double attractions of food and war pulled other production companies, state-subsidized laboratories and engineering contractors to start developing their own processes. By the mid-1920s, ammonia synthesis processes were widely available and several engineering contractors were on the market with complete plants. What triggered a building boom was cheap hydrogen from coke oven gas. Manufacture of coke, an industrial fuel made from bituminous coal, was an established business, leading to large amounts of coke oven gas as a by-product. The gas could be sold for heating and lighting purposes but contained hydrogen as well; that hydrogen, moreover, could be removed relatively simply. Many coking firms decided to enter fertilizers; there were already 39 ammonia plants in 1927 but by 1936 there were no less than 105 and capacity had increased almost 6 times.[20]

DSM was part of this building boom. Established in 1902 as a mining company by the Dutch state, it built two large coking plants in the 1910s and 1920s and entered large-scale fertilizer production in 1930.[21] The market, however, could not keep up with the jump in production, and prices dropped amid a generally miserable macro-economic climate. The nitrogen fertilizer industry, led by European firms in particular, cartelized and stabilized the market. Until into the 1960s, the industry lived by the principle of "home markets for home producers"; the shortfall in domestic supply was met by foreign producers and other export markets, particularly in the Far East, were shared (or divided) as well.[22] In the Netherlands, the three nitrogen fertilizer producers established a central sales office to regulate supply and demand.

DSM's strategy in the fertilizer industry was one of expansion. Already in 1930, when prices dropped much further and faster than anticipated, DSM expanded its plants and dwarfed the other two Dutch nitrogen fertilizer producers. After the Second World War, the company continued to expand. The coal mining operations flourished but DSM's executive board wanted to grow a second leg in chemicals and diversified into new business (in fiber intermediates and plastics in particular) and expanded existing chemical businesses (fertilizers in particular). The company also invested heavily in R&D, leading to, in fertilizers, a world class production process for urea, a key export product.[23]

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[19] Anthony S. Travis (1998). High pressure industrial chemistry: The first steps, 1909-1913, and the impact. Anthony S. Travis, Harm G. Schröter, Ernst. Homburg & Peter J. T. Morris, Eds. *Determinants in the evolution of the chemical industry, 1900-1939: New technologies, political frameworks, markets and companies.* Dordrecht: Kluwer Academic Publishers, 3-21.

[20] Arjan van Rooij (2005b). Engineering contractors in the chemical industry: The development of ammonia processes, 1910-1940. *History and Technology* 21(4), 345-366.

[21] Arjan van Rooij (2004). *Building plants: Markets for technology and internal capabilities in DSM's fertiliser business, 1925-1970.* Amsterdam: Aksant. 61-89.

[22] See: G.W. Stocking & M.W. Watkins (1946). *Cartels in action.* New York: Twentieth Century Fund. 118-130. Th. P. van Berkel (1997). *Thirty-five years of Nitrex AG.* Zurich: Nitrex AG.

[23] Arjan van Rooij (2007). *The company that changed itself: R&D and the transformations of DSM.* Amsterdam: Amsterdam University Press. 59-136.

By the late 1960s, DSM was a very large producer of nitrogen fertilizers. The company produced about nine thousand tonnes of nitrogen in ammonia in 1930; this grew to almost 430 thousand tonnes forty years later.[24] The production site in Geleen (in the south of the Netherlands) was the third largest in Europe (see Table 1). DSM also focused production on one site.[25] ICI, by comparison, had a very large site in Billingham (where it had opened its first ammonia plant in 1923) but also operated two much smaller sites. Similarly, in urea, the main export nitrogen fertilizer, DSM was very large; in 1964, DSM had the second largest production capacity for urea installed on one site; only Du Pont, a much larger American company, had a larger site.[26]

Nitrogen fertilizers were also very important for the company; it was a large business that, symbolically, marked the entry of the mining company into the chemical industry. Mining and coking struggled around 1960 to make a profit, partly as a result of the discovery of huge natural gas deposits in the Netherlands, prompting the Dutch government to decide in 1965 to close down coal mining altogether, and making further expansion in chemicals a necessity if the company were to survive and to provide much-needed jobs in the region.[27]

In its expansion, DSM increasingly relied on exports. Consumption of nitrogen fertilizers in the Netherlands was relatively high, and continued to grow until the mid-1980s, but DSM and the Dutch industry also exported large amounts (see Table 2). The principle of "home markets for home producers" ensured stable prices on the Dutch market but export markets were volatile. China and India became important importers of fertilizers but central government agencies bought fertilizers in these countries and got substantial buyer power because of the volumes involved. Prices were lower than on the Dutch markets and continued to drop in the 1950s and '60s.[28]

Table 1: The biggest and smallest ammonia production sites in Europe in 1967

Company	Country	Ammonia capacity (installed, 1000 tonnes/ year)
ICI	UK (Billingham)	900
BASF	Germany	850
DSM	Netherlands	505
Dansk-Norks Kvaelstoffabriek I/S	Denmark	35
Fertilizantes de Iberia SA	Spain	35

[24] Letter Huurdeman, (personal papers Theo Huurdeman), 5 November 1997.
[25] In 1963, DSM started a fertilizer complex in the United States; initially this was joint venture with the Pittsburg Plate Glass Company but DSM acquired full ownership in 1972. See: Ernst Homburg & Arjan van Rooij (2004). *Groeien door kunstmest. DSM Agro 1929-2004.* Hilversum: Verloren. 120-123.
[26] See: Upswing in Urea. *Chemical Week* (25 April 1964), 185-190, 194, 196.
[27] For this transition see: F A M. Messing (1988). *Geschiedenis van de mijnsluiting in Limburg. Noodzaak en lotgevallen van een regionale herstructurering 1955-1975.* Leiden: Martinus Nijhof.
[28] *Groeien*, 192-193, 206-209, 254-257.

Source: A. Erdely (1968). *European petrochemical facts.* Park Ridge, NJ: Noyes Development Corporation. 16-24.

Table 2: Export surplus of the Dutch nitrogen fertilizer industry

Year	Output available for export	
	1000 ton N	As % of production
1945/46	-4	x
1950/51	60	32
1955/56	130	45
1960/61	224	54
1965/66	267	47
1970/71	854	69

Note: Export surplus = production + imports - fertilizer use in the Netherlands. (Following: U. Ewald (1957). Recent developments of the world fertilizer market: A statistical analysis. Kiel: Institut für Weltwirtschaft. 22-23.)
Years are fertilizer years.

Source: Arjan van Rooij (2004). *Building plants: Markets for technology and internal capabilities in DSM's fertiliser business, 1925-1970.* Amsterdam: Aksant. Table 7.2, 147.

3. Change in the chemical industry: The 1970s and beyond

Table 3: Changes in the chemical 'top-10', 1980-2011

1980	Sales (billion $)	2011	Sales (billion $)
Hoechst	14,1	BASF	79,6
Dow	14,1	Dow	60,0
BASF	13,8	Exxon Mobil Chem	58,1
Bayer	13,7	Sinopec	57,9
ICI	13,7	Sabic	50,6
DuPont	10,6	Shell Chemicals	50,6
Union Carbide	10,0	DuPont	38,0
Montedison	8,4	LyondellBasell	37,3
Shell Chemicals	7,6	Ineos	33,0
DSM	7,0	PetroChina	29,6

Sources: Aftalion (1988), 375-377; Aftalion (1991), 375-376; Aftalion (2001), 406-407; ICIS Chemical Business, 10-16 September 2012, p. 33

When Alfred D. Chandler published his famous book *Scale and Scope: The Dynamics of Industrial Capitalism* in 1990, several large chemical companies, that had emerged during the Second Industrial Revolution, figured prominently in that book: the three German IG Farben successors – BASF, Bayer, and Hoechst – the British giant ICI, and American companies such as DuPont and Union Carbide. Obviously these companies had developed successful organizational capabilities, so that they could keep their positions as industry leaders for almost a century. Today though, that situation has changed completely. Between about 1980 and 2010 a 'revolution' took place in the chemical industry, and in several other industries as well (Table 3)

Although some companies – BASF, Dow, PuPont and Shell Chemicals – have successfully kept their positions within the 'top-10', others have completely disappeared, and don not exist anymore (Hoechst, ICI, Union Carbide). They, and companies that dropped out of the top-10, were replaced the chemical divisions by oil companies (e.g. Exxon Mobil), by companies from China (Sinopec, PetroChina) and Saudi Arabia (Sabic), or by newly founded companies that resulted from large scale port-folio rearrangements (LyondellBasell, Ineos).

In order to better understand the dynamics of the industry, it is important to distinguish between different developments that took place, and analyze the 'drivers' behind them.[29] The first of these developments relates to the changing relationship between the chemical and pharmaceutical industries. After a rapprochement between these two industries during the 1960s, 1970s and early 1980s, then several large chemical companies took over small pharmaceutical companies, or expanded their existing pharmaceutical businesses (e.g. BASF, Dow, DuPont, ICI, Hoechst), after about 1990 the trend reversed, and many 'mixed' chemical-pharmaceutical companies were split-up into their chemical and pharmaceutical parts. Major cases in point are Hoechst, that – apart from divestments to several existing companies -- was dissolved into a pharmaceutical (Aventis, now part of Sanofi) and a chemical branch (Clariant), and ICI, that was split-up into a pharmaceutical company (Zeneca), a fertilizer producer (Brunner Mond, now part of Tata Chemicals), and a coatings company ('new ICI', now part of Akzo Nobel); moreover, the PVC activities were sold to Ineos. The formation of more focused pharmaceutical companies was followed during the last two decades by numerous mergers in the pharmaceutical field, giving rise to giants such as Pfizer, Novartis, Merck, Sanofi, AstraZeneca, Roche and GlaxoSmithKline.

Major drivers of these developments are of two different kinds. In the first place, a very important role has been played by the dynamics of the financial and stock markets during the last three decades: increased importance of 'shareholder value', and the rise of aggressive venture capitalists and hedge funds that often put strong pressures on the leaders of 'mixed' companies

[29] This section is mainly based on: Peter H. Spitz, Ed. (2003). The chemical industry at the millennium: Maturity, restructuring, and globalization. Philadelphia: Chemical Heritage Press. Louis Galambos, Takashi Hikino & Vera Zamagni, Eds. (2007). *The global chemical industry in the age of the petrochemical revolution.* Cambridge: Cambridge University Press; Ernst Homburg, 'The years of diversification and globalization (1950-2012), pp. 331-564 in: Kenneth Bertrams, Nicolas Coupain & Ernst Homburg (2013). *Solvay: History of a multinational family firm.* Cambridge: Cambridge University Press; Dr. Udo Jung (BCG =

to spit their firms into a high-profit pharmaceutical company, and a lower profit chemical branch. In the second place, developments within the pharmaceutical production and sales have played a major role: rising R&D costs and lower success rates in finding new drugs, increased government regulation of pharmaceutical markets, growing competition from producers of so-called generic drug, of which the patents have elapsed, and, as a result, increased world-wide competition between the major players. Increasingly, mergers proved to be necessary to stay in the innovation race, in order to spread the growing R&D costs over a larger sales volume.

Although countries such as China, India and Brazil are of increasing importance as producers of generic drugs, the pharmaceutical 'majors' are still predominantly American and European. The USA is still the largest pharmaceutical market by far, followed by Japan and Europe.

For the chemical industry the situation was rather different. Of course, the influence of shareholder value and hedge funds also had its impact here, because the splitting-off of the pharmaceutical divisions had immediate impact on the company that was left behind. Also the agrochemicals activities were mostly spun-off for similar reasons, on the basis of their higher profitability (in the case of crop protection and seeds), or the cyclic nature of their profits (as in the case of nitrogen fertilizers), or because of their higher risk profile (as in the case of Shell Chemicals). But other factors played a role as well.

In the first place oil feedstocks had a tremendous impact during the period discussed here. As a result of the first oil shock (1973-1974) many chemical companies started to diversify into products with higher value added, such as biotech products, complex ceramic products, high performance plastics and fibers, etc. The second oil shock (1979-1980) reinforced that tendency, but had at the same time a stronger impact on the profitability of petrochemical bulk chemicals (plastics and nitrogen fertilizers in the first place). Chemical companies without in-house petrochemical feedstock suffered heavy losses. As a result, the chemical division of the oil companies (Exxon Mobile Chemical, Shell Chemicals, Sabic, PetroChina) were able to expand their activities considerably within the chemical field.

Parallel to these two oils shocks, the Western economies suffered a severe economic crisis (stagflation, unemployment, low economic growth), and as a result most of the larger chemical companies re-oriented part of their sales and production to markets with higher growth rates: Asia (China, India), but also other emerging economies (Mexico, Brazil, and Russia). This led to a geographical re-distribution of the chemical industry, from USA and Europe to Asia and other regions of growth. In table 3 this is reflected the growing importance of companies such as Sinopec, Sabic, and PetroChina.

As a result of rising feedstock prices and lower growth rates in demand the bulk chemical industry during the 1980s and, especially, the 1990s heavily suffered from lower margins. The

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The Boston Consulting Group), 'The Future of Value Creation in the German Chemical & Pharmaceutical Industry.' Frankfurt, 19 June 2012. (Achema 2012).

classic answer to such situations had been the formation of cartels that could stop the erosion of market prices. After the US had taken the lead with their anti-cartel policies, the European Union followed slowly but steadily from about 1980 onwards, when the implementation of already existing law became increasingly stringent. The answer developed by the industry, as well as by management consultants, now became: focus on core activities, where your company as a leading position. During the last two decades this has been a dominant policy followed by most major chemical companies. Lesser positions were spun-off and sold to companies that were leaders in those field. Next to that the creation of joint-ventures became a means to enlarge market power. Typical examples of these trends are the creation in 2000 of Basell by BASF and Shell Chemical, in 2007 followed by the creation of LyondellBasell, with world dominance in polypropylene and other polyolefins; and Ineos, established in 1998 by venture capitalists, which is now one of the major players in vinyls.

As a result of these changing roles of shareholders, feedstock prices and supply, regional re-distributed growth of consumption, and, finally, mechanisms to gain market power, the organization of the chemical industry changed completely during the last 20 to 30 years. Contrary to the 1960s, when diversification was king, now most companies drastically reduced the width of their product portfolio’s. Only very few companies, BASF in the first place, stuck to the ‘Verbund’ concept of a vertically ànd horizontally integrated company.

4. DSM and ammonia

The changing tide in fertilizers

Around 1970, DSM was faced with a challenging environment in nitrogen fertilizers; technologies, feedstocks and markets all changed radically. Around 1960 it was clear that the days of the coal-based chemical industry were numbered. American industry was advancing fast, an expansion fuelled by oil and natural gas, and in 1959 natural gas was discovered in the Netherlands. DSM introduced natural gas gradually. After the last coke oven plant closed in 1968, fertilizer production was completely based on natural gas.[30]

The switch in feedstocks coincided with a technological change. Ammonia production consisted of several steps; production of hydrogen and nitrogen was separate from ammonia synthesis, and a compressor plant was wedged in-between to get the gas mixture at the desired pressure. Expanding production meant building an additional unit to the plant; in 1966, for instance, the 11th unit of DSM's synthesis plant started. In the early 1960s, however, M.W. Kellogg, an American engineering contractor working in close cooperation with the British chemical company ICI, devised a way to integrate the separate parts of ammonia production and scale it up at the same time: the so-called single train plant was born; natural gas was fed into it, and ammonia came out of it (as well as carbon dioxide that could be used in urea manufacture).[31] Together with ethylene, ammonia was the first product in which this type of scale-up was achieved.[32]

Single train ammonia plants came in two flavors only - large (680 tonnes of nitrogen in ammonia per day) and extra large (1.000 tonnes) - complicating decision-making: the smaller plant provided only just enough ammonia to replace coal-based ammonia production but the larger plant provided too much. However, the economies of scale were attractive: ammonia from the largest plant cost 10% per tonne less than a smaller big plant, a very substantial difference; compared to the old plant, the big plant was almost 30% cheaper. DSM took the plunge in and hired an engineering contractor to build largest possible singe-train plant; it started in 1971.[33]

The fertilizer market changed profoundly as well. On export markets, the balance of power shifted because feedstock-rich nations entered the fertilizer industry. After the first oil shock, fertilizer prices rose sharply and countries around the Persian Gulf in the Middle East, but also Russia (then the Soviet Union) and Trinidad, wanted to upgrade their natural resources by producing ammonia (and using the ammonia to produce urea). In ammonia and fertilizers, particularly Western-European producers lost ground; many were landlocked (like DSM) and paid relatively high prices for natural gas (again like DSM). Although Dutch nitrogen fertilizer producers typically got the lowest prices of all Dutch consumers, they still struggled to compete with the prices vertically integrated companies could work with.[34]

Markets for technology played a crucial role in this shift in the nitrogen fertilizer industry. Engineering contractors quickly diffused state-of-the-art single-train ammonia plants. Like DSM, other established producers feared to be left behind their competitors. Engineering contractors also facilitated resource-rich nations to start producing fertilizers. DSM, however, also supplied this market. Its R&D department developed a leading urea production process in the 1960s. DSM licensed this process widely, because monopolizing this technology was impossible; the urea market was simply too large and alternative technologies were already available. The ready availability of state-of-the-art technology, however, added further to the fierce competition between firms.[35]

A second crucial development on the fertilizer markets was the gradual crumbling of the national and international cartels. An important external source of pressure was tightening cartel regulation instigated by European economic integration. Western-European producers also re-discovered their neighbor's markets as exporting to places such as India and China got

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[30] Van Rooij 2004, 203-215.
[31] Robert H. Multhaup & Gunther P. Eschenbrenner (1996). *Technology's harvest: Feeding a growing world population.* Houston: Gulf Publishing.
[32] Spitz 1988: 426-437.
[33] Van Rooij 2004, 224-227; cost prices: table 9.5, 225.
[34] Hans Heerings & Wicher Smit (1986). *Internationale herstrukturering in de kunstmestsektor.* Amsterdam: SOMO. Chapman 2000, particularly figures 2 and 3, 376.
[35] Van Rooij 2004, 137-172.

increasingly difficult. This put "home markets for home producers" under further pressure; the central sales office of the Dutch nitrogen fertilizer producers finally collapsed in 1979.[36]

Table 4: Production locations: An overview of closures and divestures

Location	Country	Main fertilizer	Origin	Started	Acquired (into DSM)	Closed (by DSM)	Divested (by DSM)
St. Paul	France	Mixed	Lecoester	1957	1972	1982	-
Amsterdam	Netherlands	Phosphate	ASF	1907	UKF	-	1982
Augusta	USA	Nitrogen	DSM	1963	-	-	1986
Gent	Belgium	Phosphate	Moreels	1925	1972	-	1986
New Ross	Ireland	Mixed	Albatros	1953	UKF	-	1987
Rotterdam	Netherlands	Phosphate	ASF	1910	UKF	-	1988
Rotterdam	Netherlands	Nitrogen	AU	1967	UKF	-	1988
Ince	UK	Nitrogen	Shellstar	1965	1973	-	1988
Gouaix	France	Mixed	Lecoester	1963	1972	-	2002
IJmuiden	Netherlands	Nitrogen	MEKOG	1930	UKF	2010	-
Geleen	Netherlands	Nitrogen	DSM	1930	-	-	2010

Source:	Ernst Homburg & Arjan van Rooij (2004). *Groeien door kunstmest. DSM Agro 1929-2004.* Hilversum: Verloren. 311-320. DSM gaat Agro fabriek in IJmuiden sluiten, 4 March 2008. <http://www.rtl.nl/components/financien/rtlz/2008/weken_2008/10/betten4023594.xml>, 29 April 2013.
Note:	In the table the predominant fertilizer type is noted; by the 1960s, most of the sites were making mixed fertilizers as well.
Abbreviations:	
-AU	Ammoniak Unie, Joint venture by MEKOG and BASF.
-ASF	Amsterdamsche Superfosfaat Fabrieken
-Moreels	G.&V. Moreels & Belgische Peruguano Maatschappij
-Lecoester	S.A. Etablissements Christaen-Lecoester

DSM's response: Consolidation

In the 1970s, DSM remained fully committed to nitrogen fertilizers. In 1971 its fertilizer business merged with the Verenigde Kunstmestfabrieken (VKF) to form the Unie van Kunstmestfabrieken (UKF), with DSM retaining a 60% majority share. VKF was the result of a merger between MEKOG, a producer of nitrogen fertilizers, and Albatros, the major producer of phosphate fertilizers in the Netherlands, in 1961. Both DSM and VKF saw the merger as a means to keep control of the lucrative Dutch market while shifting the focus in exports towards Western-Europe.

[36] *Groeien*, 255-257.

UKF promptly started to build a position on European markets, in particular through acquisitions in the United Kingdom, Belgium and France (see Table 4), and the opening of a sales office in Germany. In 1973, with a total capacity of 1.4 million tonnes of nitrogen in fertilizers, DSM-controlled UKF was the largest fertilizer company in Western-Europe.[37]

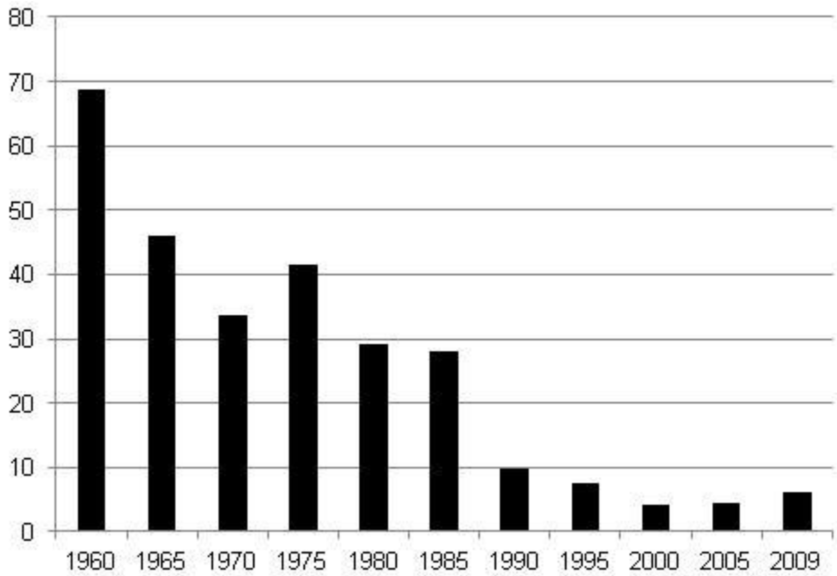
By buying out Hoogovens, a steel company, and AKZO, a diversified chemical company, DSM raised its interest in UKF to 75 percent in 1973, and by buying out the remaining shareholder Royal Dutch/ Shell in 1980, it became the sole owner UKF remained important to DSM but the nitrogen fertilizer industry was consolidating rapidly. UKF repeatedly got the opportunity to acquire other fertilizer companies. DSM's board, however, rejected several deals because the company did not have the money and did not believe the acquired companies would be profitable enough; some possible acquisitions also fitted poorly with a focus on the Western-European market.[38] In addition, DSM was shifting its course. The company had expanded tremendously in bulk chemicals in the 1970s but the results were rather mixed; the company grew in size but not that much in profitability. As a result of these developments, and of the first and second oil shocks especially, the profitability of existing businesses and of investments got scrutinized closely. In turn, this led to a deeper change: DSM gradually shifted its course from high-volume but low-margin bulk chemicals towards innovative products with higher value-added. Fertilizers lost a lot of their strategic importance in the first half of the 1980s. Meanwhile the fertilizer industry consolidated and UKF lost its leading position to Norsk Hydro.[39]

Still, DSM invested in its fertilizer business, renamed DSM Agro in 1986, but the motivation for these investments changed. UKF built a third ammonia plant in Geleen, but, underlining how much the industry had changed since the 1950s, this third plant was not primarily aimed at expanding capacity but at cutting costs. DSM's collage-like first ammonia plant from 1930 was too expensive but replacing this capacity was not straightforward. Building a large plant would lead to an excess of ammonia but building a smaller plant would make production costs too high. In 1980, however, DSM interested the Belgian company Carbochimique to participate in a large plant. The plant went on stream in August 1984.[40]

DSM's response - continued: Retrenchment and divestment

Figure 3: The declining importance of the fertilizer business for DSM’s total sales (in percent)

[37] *Groeien*, 239-248.
[38] *Groeien*, 274-276.
[39] Van Rooij 2007, 138-141; 195-201.
[40] *Groeien*, 270-273.



Note: Fertilizer sales as a percentage of total sales, excluding energy (coal, natural gas).
Sources: Annual reports DSM, *Groeien*, table 13.1, 251.

As DSM grew in other directions, the fertilizer business contributed less and less to DSM's sales (Figure 3). In the 1980s, the results of the fertilizer business continued to go up and down but were generally poor; modernizing old plants, closing plants that were too inefficient to revamp, but also improving product quality and upgrading service to farmers, were used in an attempt to improve results. However, DSM Agro incurred losses for three years after 1985; Agro's board concluded that cost cutting no longer worked and started to close poorly performing locations (Table 3).[41] This policy resulted in a transformative deal with the Finnish company Kemira Oy, struck in 1988. Like Norsk Hydro, Kemira wanted to become a global player in fertilizers and had been on an acquisition spree since 1982.[42] Kemira showed interest in DSM Agro's site in Ince (United Kingdom) but ended up buying two Dutch sites as well. In turn, DSM Agro acquired full ownership of the third ammonia plant in Geleen; Kemira had already bought the mother company of Carbochimique in 1986. Ultimately the deal cost DSM money but it fitted with its overall business strategy and repositioned the fertilizer business. DSM Agro retrenched. It now only made straight nitrogen fertilizers again and sold them mainly on the Western-European market.[43]

DSM Agro lost a third of its sales and a third of its personnel to Kemira; it now mainly operated two sites, one in Geleen (the cradle of DSM) and one in IJmuiden (the cradle of the former MEKOG). DSM Agro focused on cost leadership. A new, big fertilizer product plant was built in Geleen in 1993, for instance, to streamline production and cut costs. A year later the production of mixed fertilizers, containing both nitrogen and phosphate, was concentrated in IJmuiden. At the same time, the ammonia plant at IJmuiden was closed down. A single product

[41] *Groeien*, 277-279. Results: *Groeien*, table 13.1, 251.
[42] *Groeien*, 274-275.
[43] *Groeien*, 292-295. In 1986 DSM also sold its fertilizer subsidiary CNC in the USA.

was now made in Geleen, maximizing economies of scale and simplifying logistics. Further cost-cutting and rationalization measures were repeatedly necessary but were successful in maintaining profitability.[44] However, DSM continued to change and fertilizers fitted less and less well within the company. In 2010, the site in IJmuiden was closed. The site in Geleen was sold to Orascom Construction Industries (OCI) from Egypt; OCI bought the tightly integrated ammonia, nitrogen fertilizer production plant, and urea and melamine plants.[45] A history of more than eighty years of fertilizer manufacture at DSM had come to an end.

5. Solvay

During decades soda ash was one of the most important cash cows of the Solvay Group.[46] Next to being the largest soda ash producer in the world – with a global market share of more than sixteen percent in the 1960s – Solvay especially had an extremely strong position in Western Europe, with market shares ranging from sixty percent in France and Germany to almost 100 percent in Belgium, Austria, Italy, and Spain.[47]

Since about 1975 that situation gradually started to change. Market conditions in Europe, the USA and Japan deteriorated due to a slowing down of economic growth, but also because of specific causes, such as the growing recycling of glass, changing laundry practices, the partial substitution of soda ash by caustic soda, and, last but not least, the growing global power of Solvay's major customers in glass manufacture (Saint-Gobain; Asahi, etc.) and detergents (Procter and Gamble; Unilever; etc.). Growing imports from Central and Eastern Europe, often from former Solvay plants, as well as from the USA, made the situation worse. Stimulated by overcapacity in the USA and helped by a low dollar rate, American producers of natural soda entered the European market in 1978 and had become by 1980 a dangerous threat. Soda ash prices in Europe went down and several of the smaller Solvay plants were producing with losses.[48]

To defend its leading position Solvay did all it could to reduce its production costs, mainly by improving the energy efficiency of the plants, as well as by closing down the smallest plants and concentrating the production capacity in the larger ones. Those at Sarralbe (1983)

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[44] *Groeien*, 295-298.
[45] Annual report DSM 2010; Patrick Marx, 'Egyptisch bedrijf runt Nedrlandse kunstmestfabriek,' Chemisch2Weekblad, 12 April 2013, pp. 34-35.
[46] This section is (provisionally) taken from Kenneth Bertrams, Nicolas Coupain & Ernst Homburg (2013). *Solvay: History of a multinational family firm.* Cambridge: Cambridge University Press, pp. 507-510.
[47] ACS, CdG, 24 Sept. 1958; "Parlons produits: Le carbonate de soude (Na2CO3), matière fondamentale," *Revue Solvay* (March-April 1969): 5-8.
[48] ACS, 1010-10, presentation Mr. Vinçotte, 12 May 1980; E. Coppens and H. Dessart, "Adapting to the new conditions of the sodium carbonate market," *Revue Solvay*, (1983) (2): 17-19; ACS, 1001-26-1, "Note au Comité Exécutif – Proposition de strategie carbonate 1995-2000," 2 May 1994.

and Zurzach (1987) were closed, whereas the soda ash plants at Rosignano and Torrelavega, both close to the sea, were enlarged.[49]

Due to these measures, to a higher dollar rate, and to special contracts with large customers, for which the company later was fined by the European Commission, Solvay succeeded in improving its results in soda ash considerably during the second part of the 1980s. When the rate of the dollar again began to fall though, Solvay from 1988 onwards was increasingly threatened by imports from natural soda ash from the USA, in a declining market. Imports into the EC from the USA and from Central Europe grew from four percent of the market in 1990, to fourteen percent in 1992. As a result Solvay's soda ash position deteriorated sensitively within a few years, especially in Northern Europe, and Solvay's ROI in soda ash and its derivatives declined from 34.3 percent in 1990 to a mere 3.5 percent in 1993.[50]

This time, Solvay's answer to these attacks on its leadership was not only defensive, such as the closing down of Couillet and Heilbronn; it was also offensive. New technology (gas turbines with cogeneration) was introduced to reduce the energy costs, prices of soda ash were lowered in Northern Europe – a great departure from usual practices – in order to compete with Akzo and Brunner Mond, and, most importantly, three new large-scale soda ash plants were acquired: at Bernburg in Germany (1991), at Green River in the USA (1992), and at Devnya in Bulgaria (1997). The strategic significance of these three acquisitions was great. Bernburg was well situated in relation to the Central European markets, but it first had a difficult time, due to overproduction in Western Europe and the collapse of the Eastern economies. The acquisition of the large Green River plant of Tenneco was the culmination of many efforts to get a foothold in soda ash in the USA. Despite the very high price of $ 500 million it greatly improved Solvay's global position in soda ash. It not only helped to reduce the import pressure on Solvay's European home market, but it also proved to be a bridge head for the markets of Asia and Latin America. Within a few years the capacity of the Green River plant was enlarged from 1.8 Mt/y to 2.4 Mt/y.[51]

With the acquisition of the modern soda ash plant at Devnya – with a capacity of 1.2 Mt/y the largest single unit plant in Europe – Solvay had similar aims than with Green River: reducing the pressure on its home market, and gaining market share elsewhere in the world. Since the start of the dramatic changes in the former communist countries, Solvay tried hard to

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[49] ACS, 1020-10, "Reflexions sur l'actuelle situation de crise," 19 Oct. 1981; PR, "The European Community lifts antidumping rights applicable to soda ash imports from the U.S. – Solvay's viewpoint," 16 Oct. 1990; ACS, MoE, 5 Nov. 1991.

[50] ACS, MoB, 28 Nov. 1988, 29 Nov. 1993; PR, "Soda ash: The EC Commission fines Solvay for ECUs 30 million," 19 Dec. 1990; ACS, 1001-26, presentation Mr. Loutrel, 30 Jan. 1991; ACS, MoE, 25 Nov. 1992; PR, "Memorandum: Solvay's soda ash market," 14 Dec. 1993; ACS, MES meetings, B. de Laguiche, "Evolution des resultats et ROI sur 10 ans," 20 May 1997.

[51] ACS, MoB, 27 July 1987, 30 Jan. 1990, 29 Jan. 1992, 27 Nov. 1995; ACS, MoE, 28 July 1987, 4 July 1989, 17 Dec. 1991; ACS, 1001-26, "Politique générale du groupe," 14 March 1988; ACS, 1059-2-6, "Le carbonate de soude en Europe – Situation début 1992," 11 Febr. 1992; PR, "Solvay Minerals, Inc.: Capacity expansion," 12 July 1995; PR, "Solvay Minerals expands soda ash in Wyoming, USA to 3,5 million short tons/year," 24 July 1996; O. Montfort, "Solvay, soda ash and trona…," *Solvay Live*, (Autumn 1996): 10-11.

acquire again one of its former Polish plants at Podgorze and Inowrocław, but unsuccessfully. A new option opened up when early 1996, following high inflation in Bulgaria and pressed by the IMF, Bulgarian government decided to privatize the gigantic “Sodi” soda ash plant at Devnya, one of the few soda ash plants in the world with a harbor that could receive large seaborne vessels. Despite the risks involved – the plant was performing badly – Solvay decided to acquire sixty percent of the shares, the rest being reserved for local shareholders. In April 1997 a final agreement was reached, and the name of the new company was changed to Solvay Sodi. One quarter of the product was marketed by Sisecam in Turkey; the remaining three quarters were sold by Solvay to Eastern Europe, Central Asia, the Middle East and elsewhere. Devnya, located close to the Black Sea, was an excellent location for export. Solvay decided to invest heavily in the plant, as well as in securing its supply of raw materials (salt, limestone, steam, electricity).[52]

By these acquisitions and large investments Solvay succeeded in raising its competitiveness in soda ash within a few years. With a growth of its production capacity from 4.6 Mt to 7.5 Mt between 1991 and 1997, despite the closure of two plants, Solvay remained the undisputed global leader in soda ash. When early 1998 the incoming chairman of the ExCom, Aloïs Michielsen, looked back on what had been achieved, he called Solvay’s European soda ash strategy a model on how to become as competitive as its American peers In the twenty-first century, Solvay entered into alliances and joint ventures in soda ash in China and acquired the Alexandria Sodium Carbonate company in Egypt (2008). An attempt to regain control, after almost a century, over Solvay’s “good old” plant at Berezniki, Russia, could not be realized though.[53]

6. Changing in a competitive world: The dynamics of bulk chemicals after 1970 - and what we can learn from that

DSM and Solvay, and ammonia and soda ash, are broadly comparable yet the geographical and competitive patterns before and after 1970 differ significantly. DSM exported ammonia fertilizers all over the globe before 1970 but, forty years later, increasing competition has confined it to a much smaller market. DSM's plant are still producing but are currently owned by an Egyptian firm.

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[52] ACS, MoE, 25 Nov. 1992, 26 Sept. 1995, 27 Febr. 1996; ACS, 1001-26-1, “Note au Comité Exécutif – Proposition de strategie carbonate 1995-2000,” 2 May 1994; ACS, MoB, 12 Dec. 1996, 31 July 1997, 23 March 2000; PR, “Solvay signs a preliminary agreement with Bulgarian authorities on acquisition of 60 percent of Sodi shares,” 19 Dec. 1996; PR, “Solvay Group finalises deal with Bulgarian authorities on the acquisition of Sodi Devnya,” 15 April 1997; O. Monfort, “Solvay-Sodi, in Bulgaria, on the Black Sea – Solvay moves Eastward,” *Solvay Live*, (Summer 1997): 16-17; PR, “Solvay Sodi takes control of three Bulgarian suppliers,” 3 Aug. 2000.

[53] ARS 1997: 5-9; O. Monfort, “Soda ash and derivatives SBU: Strategy of world leader,” *Solvay Live*, 63 (Spring-Summer 1999): 20-1; PR, Press release, alliance with NCI, Sinopec in China, 13 May 2004; PR, acquisition of Alexandria Sodium Carbonate company in Egypt, 17 Oct. 2008; PR, Acquisition of Berezniki Soda Ash plant cannot be finalized, 10 June 2010.

Solvay, by contrast, moved its soda ash plants to sea ports, and it still exporting its products to a large geographical area. How can this be explained?

The optimum economic size of ammonia and soda ash plants quickly outgrew the size of the home market, making the profitability of those plants strongly dependent on export markets. Scale-up also steadily continued, leading to extremely large plants by the 1960s. As market growth slowed down after 1970, this led to severe boom-and-bust cycles in bulk chemicals; production capacity could only be expanded in big bumps that outstripped demand at least for some time to come, squeezing the profitability out of the industry. The cartels also crumbled. The gradual emergence of a more integrated European market toughened up relations among chemical companies. Stricter regulation, moreover, outlawed the very tools that had been so effective before to deal with competition: market sharing arrangements, production quota deals, and price fixing.

In addition, both soda ash and ammonia are strongly dependent on the cheap supply of energy (and in the case of soda ash on the supply of salt and limestone as well). In this sense, vertically and backwardly integrated companies have a strong advantage over competitors. An important part of the explanation for Solvay's continued leadership can be found here. In ammonia, on the other hand, the switch to natural gas during the 1950s and '60s was an important watershed; it sowed the seeds of the advantage of hydrocarbon feedstock-rich locations, i.e. locations typically not found in the traditional mainstays of the industry in Western-Europe and, to a lesser extent, in the United States.

Large scale plants and the need for cheap feedstocks tilted the playing field to the disadvantage of companies like DSM: landlocked and with little control over feedstock prices. Solvay, however, remained vertically integrated. In addition, the Belgian company managed to keep control of soda ash technology. Patents but, above all, secrecy and continuous improvement proved effective in maintaining the technological lead the company captured as first mover in the late nineteenth century. In ammonia, by contrast, technology was widely and readily available since the mid-1920s. As the entry of DSM into the fertilizer industry shows, companies with some technological capability, money and entrepreneurial spirit could start making ammonia - and many did.

Business strategy and corporate identity also played an important role. At Solvay, soda ash retained an unassailable position in the group regardless of the erosion of profitability (when compared to the levels of the early twentieth century). At DSM, in contrast, lower margins put ammonia under pressure and discussion, ultimately resulting in the sale of the fertilizer division in 2010. Even so, the plants remain in operation; this can only be considered a stark reminder of the dynamics of bulk chemicals. The plants remain competitive, yet not at the same level and in the same region as the plants were in the late 1960s. As the comparison of DSM and Solvay shows, the much smaller growth, when compared to the past and to other products, has become a poor fit with the strategies of some companies and, consequently, they have put their focus elsewhere.

The contrasting examples of DSM and Solvay ultimately show that industry evolution is not a deterministic process (although, of course, it can be described in this way). This is an important conclusion in a time when far too often the changes in industry geography are simply presented as such; industry re-location is not caused by the gales of low cost competition only (be it low labor cost or cheap feedstocks).