The 'back to the future' move by China to coal based chemistry has the potential to revolutionise certain chemical sectors, not only in China, but globally.

If we are to go back to the 19th century, the chemical industry of the day was reliant on coal and bio-based feedstocks (the latter is a story for another day). However the rise of cheap oil and natural gas after the Second World War meant that the chemical industry until the end of the millennium had very little reliance on coal. This changed in the late 1990’s when a combination of rising energy prices, explosive growth in the Chinese manufacturing sector and a relative abundance of coal in China relative to crude oil and natural gas forced China to reconsider the possibility of using coal as a feedstock for its rapidly emerging chemical industry.

Three chemical products which have become very reliant on coal as a feedstock in China are PVC, methanol and ammonia.

Vinyl chloride monomer has been produced from coal via acetylene since it was first synthesised in the 19th century, but by the 1950’s the ethylene route had taken over thanks to a combination of cost (the coal route could not compete against the ethylene route when oil was below $20 per barrel) and environmental concerns (the production of acetylene from coal uses a mercury based catalyst). However by the turn of the millennium 50 % of China’s PVC was produced from coal and today 75 % is coal based and there is capacity in China to produce almost double the amount being produced today. The outcome of this is that PVC is one of the few major commodity chemicals and polymers for which China is self-sufficient, meaning no PVC project can rely, as most petrochemical projects do, on a large Chinese import market into which product, which can not sold domestically, can be placed.

Similarly it has been long established that syn gas (the feedstock for both methanol and ammonia) can not only be produced from natural gas (methane) but also coal. Similarly to PVC, the majority of of Chinese methanol and ammonia production is coal based and, the global methanol industry now has China as a major swing producer, created a band of prices within which the product trades. When prices fall too far, Chinese coal based producers shut down, tightening the market and pushing prices up, but when they rise too far, the Chinese marginal producers restart, increasing supply and placing a ceiling on price.

The next industry likely to be affected by the rise of coal based chemistry in China is the olefin and polyolefin industry, in particular ethylene, propylene and their derivatives. A number of Western and Chinese technology providors have developed technologies which convert methanol to ethylene and propylene in an approximately 1:1 ratio (known as Methanol to Olefins or MTO) and methanol to propylene only (Methanol to Propylene or MTP). Five years ago these technologies existed only in the laboratory, pilot plants and on paper, but there are now at least 5 of these projects operating in China with up to another 50 in various stages of development. Should these projects all proceed, it will have a significant effect on the global olefins and derivatives industries, notably Polyethylene and Polypropylene. Although Sinopec and Petrochina are both in the top 5 PP  and the top 10 PE producers globally, China imports around 8 million tonnes of PE and 5 million tonnes of PP annually. Should China become much more self sufficient in these products, it will place considerable pressure on those producers for whom China is a key market, especially those who do not have a feedstock advantage I.e. Korean, Japanese and some South East Asian producers. It will also indirectly place pressure on those non-feedstock cost advantaged producers who do not export significant volumes to China (notably those in Western Europe and Latin America), who will find increased competition from feedstock cost advantaged Middle East and North American producers in their home and regional markets as the low cost producers search for markets to replace the volumes they currently sell in China.

The rise of the Chinese coal based ethylene and propylene industry will also affect other products for which naphtha steam cracking is a major supply source, notably butadiene and aromatics, especially benzene and, to a lesser extent, paraxylene. These products are already facing structural tightness as the majority of steam cracker investment over the past 10 years and the next wave of investment predominantly use ethane as feedstock. The last 10-15 years have been characterised by considerable ethane steam cracker investment in the Middle East (Saudi Arabia, Iran, Qatar, Abu Dhabi, etc.). Further the last 5 years have seen the North American steam cracker industry move from a significant reliance on naphtha feedstock to an almost complete use of ethane following the shale gas revolution and the resulting collapse in the price of US natural gas and natural gas liquids, notably ethane. The spectacular profitability currently enjoyed by North American steam cracker operators has encouraged a wave of investment which is expected to result in a 30-40 % increase in North American steam cracker capacity by the end of the decade, all of it using ethane feedstock. A significant difference between ethane cracking and naphtha cracking is that the latter produces significant quantities of propylene, C4 olefins and aromatic co-products, whereas the former produces very little of these. Consequently the global supply ratio of propylene, butadiene, benzene and xylenes  to ethylene from steam crackers has fallen significantly over the past 10-15 years and is expected to fall further in the years ahead. China has been the only country investing significantly in naphtha cracking capacity over the past 10 years, but the emergence of the coal to olefins industry is likely to result in a reduction in naphtha cracking capacity investment in China, which will further tighten supply of butadiene, benzene and, to a lesser extent, paraxylene (for which refineries also represent a significant supply source) as the MTO and MTP technologies have no butadiene or aromatic co-products.

The significant risk to the Chinese coal based chemical industry is water supply. Coal to chemical processes are much more water intensive than traditional chemical technologies such as naphtha cracking. Water supply is a growing issue around the world including China and it is possible that policy makers may in the future restrict coal chemical operations to preserve water supply for agriculture, hydro-electric and other uses. Having said that, it currently does not appear to be an issue with policy makers recently announcing that the development of the coal chemical industry is an important pillar of future economic policy, which is reinforced by the large number of coal to olefins projects currently being developed, combined with the delay of some Chinese naphtha cracking projects.

(Paul Cherry, Consultant at Officium Projects)