SILICONES AGAINST BLACKOUTS

India's economic power is growing. However, the country is developing faster than its infrastructure. The energy grid, in particular, cannot keep pace anymore, as demonstrated by the huge summer 2012 blackout. Thousands of kilometers of new lines are needed – composite insulators based on silicones from WACKER are helping to ready the Indian power grid for the future.

July 30, 2012 in Neu-Delhi: Subways stand idly at their stations, telephone lines are dead and traffic in the Indian capital breaks down, since the traffic lights are not working anymore. As night falls, New Delhi is in the dark – along with many other parts of the Indian subcontinent. The tropical heat becomes unbearable, as the air conditioning systems break down. Nothing works anymore. In July, a dramatic blackout incapacitated India. The grids collapsed in the north, northeast and east of the country, in 20 out of 28 states – like a line of dominoes that topple one by one. 650 million people – over half the Indian population – were affected by this, the largest power outage in history.

"An additional 100,000 megawatts of power will be required over the coming five to seven years"

To experts, the blackout didn't come as a complete surprise. The Indian power grid hasn't been able to meet the rapidly rising demand for some time now. In the decade between 1999 and 2009 alone, per capita power consumption increased by around 50 percent, according to Germany Trade & Invest (the economic

The Indian megacity of Mumbai: with a population of 18 million including suburbs, Mumbai ranks among the world's five largest metro areas.

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An overhead power line in West Bengal: The power outage on July 31, 2012 brought public life in 20 of 28 Indian states to a halt, also in the state of West Bengal and its capital Kolkata.

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“Silicones Against Blackouts”

development agency of the Federal Republic of Germany). The Indian economic miracle regularly pushes its power supply to the limit. Conserving electricity is the order of the day. “That’s why so-called ‘power holidays’ are compulsory in many parts of India,” explains Dr. Jens Lambrecht, technical service manager for transmission and distribution at WACKER. “Here, companies are obliged to not consume electricity, i.e. to not produce, two days per week, for example.” These mandatory time-outs are noticeably crippling this booming emerging economy. Furthermore, the power interruptions, which are mostly brief but occur several times a day, are an endurance test for industrial production and machinery.

200 GW OF GENERATOR CAPACITY

A comparison of figures clearly shows that the provision of electrical energy is by far not enough: some 200 gigawatts of electrical-generator capacity are currently installed in India. Every Indian can thus use 170 watts, on average. By contrast, every German can draw on seven times that amount. Furthermore, 300 million Indians have no access to electrical energy at all. In rural areas, electricity is pure luxury and sometimes even tapped illegally. This unbalances the grids further and makes them more susceptible to blackouts.

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The Indian government is following ambitious plans to expand its energy grid in order to meet rising demand. “An additional 100,000 megawatts of power will be required over the coming five to seven years,” explains Vikas Jalan, joint managing director at Deccan Enterprises. The company, which has a rubber-processing tradition that spans over 40 years, has been developing and producing silicone-elastomer composite insulators for power transmission for several years and ranks among the market leaders in India.

Since electricity is mainly produced in coastal regions and the northeast and east of the country, but energy is needed nationwide, the subcontinent needs more than just new power plants. “Power transmission also needs to be expanded accordingly,” says Deccan head Jalan. New extra-high-voltage lines with voltages of 765 to 1,200 kV are in particular demand. They provide the only low-loss means of transporting the required amounts of electricity over long distances.

Insulators are a key element of energy transmission and distribution. They can be found wherever electrical conductors must be affixed, held or guided. Silicone composite insulators are currently in particular demand in India. Put simply, they consist of an electrically insulating glass-fiber reinforced rod in a weather-resistant silicone-elastomer housing. “Compared to conventional porcelain insulators, the electric silicone-elastomer composite components are significantly easier and faster to manufacture and more cost-efficient over the long term,” explains Lambrecht. This is because the insulating housing is not fired like ceramic components, which is complex and time-consuming, but applied via injection molding. With this method, production not only yields high-precision molded parts, it is also rapid and the required high quantities are possible.

AT 2,000 BAR INTO THE MOLD

“Injection-molding machines press the silicone material into steel molds at a pressure of up to 2,000 bar,” explains Harald Schmid, sales manager at Klöckner DESMA Elastomertechnik GmbH. “The design and manufacture of these molds require extensive production expertise, in particular.” The German injection-molding machine manufacturer Klöckner DESMA is now a market leader in India, too. The Indian sites have been designing and making the casting molds, which weigh several tons, for the past four years. They consist of up to 400 precision parts, must be made very accurately and must be able to withstand high injection pressures. This three-dimensional template gives the insulators their typical lamella-like sheds. “They protect

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1,200-kilovolt insulators from Deccan in grid operation (photo on left) and during application tests (right).

the component against electrical discharges that can be caused by adherent dirt," explains WACKER expert Lambrecht, a high-voltage engineer by training. In addition, the hydrophobic, i.e. water-repellent, silicone surface reduces the risk of flashover. "No electrically conductive film of water can form, which could easily happen with porcelain. Rain drops simply roll off," continues Lambrecht. So, adherent dirt does not become electrically active.

SILICONES FROM KOLKATA

WACKER and its Indian partner Metroark founded the joint venture Wacker Metroark Chemicals Pvt. Ltd. back in 1998 for the manufacture and sale of silicones. For some time now, the company has been producing POWERSIL® silicones for electrical components near Kolkata. WACKER expert Lambrecht has been involved from the start, from when the chemical company began expanding to India. Cooperation with Deccan goes back almost as far.

"We had to design very long, new silicone composite insulators for the 1,200-kilovolt test station of energy provider Power Grid Corporation of India Limited," explains Deccan head Vikas Jalan. This is because the insulators' length depends directly on the transmission voltage – almost one meter per 100 kilovolt. Deccan carried out various model calculations and simulations to optimally adjust the electrical and mechanical parameters. The entire process – from design to delivery of the finished product in June 2011 – took two years.

"Thanks to the cooperation with WACKER and the extensive expertise of the technical team for high-voltage applications, we were able to continuously improve the silicone insulators and tailor them to our customers' requirements," says Jalan. At the end of production, we have an almost ten-meter-long silicone composite insulator. The challenge associated with such large parts: "They cannot be made in one piece in an injection-molding machine, but must be constructed in stages – by step molding," explains machine expert Schmid. The process was a success: the insulator giants passed the tests in February 2012. Insulators for 1,200-kilovolt high-voltage power cables were thus designed and manufactured for the first time in India by Deccan.

LIGHTWEIGHT AND EXTREMELY STURDY

Silicones offer another property that is very important in such components: low weight. The finished product only weighs one tenth of what a conventional porcelain insulator would. Moreover, the silicone components are in no way inferior to their ceramic competition in terms of mechanical strength. Lambrecht: "The silicone insulators are lightweight, yet extremely sturdy. They can carry the weight of around 200 average cars." In addition, the material is highly resilient and offers the required long-term stability of four decades. Silicones are also better protected against vandalism than brittle porcelain insulators, because they are elastic.

According to an estimate by McKinsey, to prevent blackouts such as the one of summer 2012, India would have to double its electrical output from today's approximately 200 gigawatts to around 400 gigawatts by 2017 – a mammoth task. New power plants have to be built, as well as several thousand kilometers of high-voltage power lines to distribute the electricity. Huge quantities of silicone insulators are needed for this alone – at least six per power pole. "Since the maximum span between two carriers is 500 meters, a one-hundred-kilometer line in the simplest configuration even adds up to 1,200 insulators," calculates Lambrecht.

LIFEBLOOD OF INDUSTRIAL SOCIETY

The power grid not only relies on composite insulators. Electricity distribution requires other components, such as cable accessories, which are also based on silicone elastomers. However, India's economy can only pick up renewed pace when its power grid works reliably and covers the whole country. Electricity is the lifeblood of a rapidly modernizing society such as the Indian one. Without it, everything comes to a standstill – in India nowadays, too. ◂

INDIA'S ENERGY IN NUMBERS

- The generation capacities of Indian power plants are currently at around 200 gigawatts. Of this, two-thirds are allotted to thermal power plants – especially coal – 20 percent to hydroelectric power plants, 12 percent to other renewable energy sources and two percent to nuclear power.
- Although the electrical supply shortage in India is decreasing bit by bit, it was still at around eight percent at the end of fiscal 2011/12 – and significantly greater than ten percent at peak times.
- About a third of the electrical energy generated is lost in India's transmission and distribution network. That's one of the highest figures on a worldwide comparison.
- The installed capacity of renewable energy has increased five-fold between 2002 and 2010: from 3.5 to 16.8 gigawatts.

(Sources: Germany Trade & Invest, International Energy Agency)