

## Flow measurement in compressed air

### Energy Savings High on Kikkoman's Agenda

Kikkoman Soy Sauce is the Rolls Royce of soy sauces and the worldwide market leader in the field of naturally brewed soy sauce. Kikkoman Foods Europe BV has been producing this world-famous Japanese soy sauce for the European market in the Dutch town of Hoogezand-Sappemeer near Groningen since 1997. It has been doing so following a centuries-old tradition of natural brewing. Six years ago, an **Energy Savings Committee was established at the factory with the aim of minimizing energy consumption per litre of soy sauce produced. Results were impressive and energy consumption was drastically reduced.**

### Production Process

Kikkoman Soy Sauce is still being brewed at Kikkoman's various production facilities worldwide using the same recipe that its Board Chairman and CEO Yuzaburo Mogi's forefathers used over three hundred years ago. Every effort is made to achieve the highest possible quality levels at every stage of production. Kikkoman Soy Sauce differs from other soy sauces by virtue of the fact that it is brewed naturally. Natural ingredients such as soybeans, wheat, salt and water still constitute the main ingredients of this liquid gold.

Paul Meerman (Assistant Maintenance Manager at Kikkoman Foods Europe BV) explains, 'Although Kikkoman markets several varieties of soy sauce, the basis is always the same. Not only is the basis the same, but production methods are also the same at all locations around the world. In theory, there is absolutely no difference between the soy sauce produced in the Netherlands and that produced elsewhere in the world. Its taste is the same everywhere. The latest development in our range of soy sauces is a gluten-free variety.'

'Compressed air consumption is currently running at between 5 and 25 m<sup>3</sup> per minute'



### Quality

Raw ingredients come from Brazil, Germany and the Netherlands. Even though raw ingredients are supplied under certificate, the company still performs random sampling while unloading its deliveries. Only if all is well, are the storage silos filled. Ingredients are then transported from the silos and fed into the production process using compressed air.

Soybeans and wheat are heated under carefully controlled conditions after delivery. Wheat is roasted in hot air on a wire-mesh bed before being ground into flour. Soybeans are steamed at high temperature. The soybeans are then mixed with the wheat and a micro-organism, Kikkoman Aspergillus, that promotes the koji mould propagation process producing shoyu koji – the essential base of soy sauce. The shoyu koji is then mixed with a salt-in-water solution. It is critical that the temperature of this mash remains below a certain level during this next phase. If the temperature begins to approach the maximum permitted level, then the mash is aerated and cooled using a feed screw and air blower located beneath the bed. The mash produced during this process is called moromi.

The next phase involves fermenting the moromi. The moromi is aged in over seventy special-purpose fermentation tanks, each with a capacity of 70,000 litres (15,400 gallons). Compressed air is periodically blasted into each tank through five surrounding nozzles with a diameter of 32 mm (1¼") to achieve a more homogenous mass. During this fermentation process, compounds are formed that later lend the soy sauce its characteristic flavour. These include amino acids, peptides, sugars and halophilic bacteria. The quality of the final product, i.e. its aroma, flavour and colour, are thus determined in this crucial phase.

Five months later, the aged moromi is removed from the tanks and transported to a vertical press. In this final production phase, the moromi is pressed to separate liquid (raw soy sauce) from residual solid matter. The residue, or cake, is shipped away for processing as livestock feed. After the soy sauce has been clarified, other ingredients such as wine vinegar, sugar or syrup are then added depending on the recipe being made, e.g. Teriyaki marinade. The soy sauce can then be pasteurized and stabilized.

The soy sauce is then transported to the bottling plant. The vast majority of soy sauce produced is still bottled in glass bottles. In addition to glass bottles, use is also made of jerry cans, bag-in-boxes, and barrels and IBCs with respective capacities of 200 and 1,000 litres (44 and 220 gallons). Meerman adds, 'We also ship a portion of our output by truck to a spray-drying plant in Germany to produce powderized soy sauce. This is commonly used as flavouring in certain cuisines.'

## Compressed Air

In addition to electricity, gas and water, compressed air is also used as a power source. Compressed air constitutes an essential part of the production process described above and is also the largest cost item. For some time now, Kikkoman has been investigating options for reducing its compressed air consumption as part of the above-mentioned cost-saving programme. Bert Wijkel (Area Sales Manager at Ingersoll Rand) explains, 'Kikkoman started out in 1997 using four fixed-speed compressors (2 × 11 kW, 1 × 37 kW and 1 × 75 kW) in order to provide its production facilities with a constant supply of compressed air. These systems provided compressed air for instrumentation, process valve control, fermentation tank mixing and packaging purposes.

Although this was working fine, it certainly wasn't the most energy-efficient of solutions. This prompted us at the time to take compressed air readings. Based on these readings, it was decided to modify the compressor set-up. The two 11-kW and the 37-kW compressors were replaced by a single 75-kW, variable-speed Nirvana oil-free rotary screw air compressor. Installing this compressor allowed Kikkoman Foods Europe BV to increase its production capacity. An extra filling line was also added at that time.'

## Replacement

Before replacing the fixed-speed, 75-kW compressor last year, Ingersoll Rand once again conducted a compressed air leakage analysis using ultrasonic equipment. Conventional hose couplings were replaced with quick-connect fittings and various energy-efficient components were added at several locations in response to analysis results.

Wijkel recalls, 'It was also decided to replace the fixed-speed, 75-kW compressor with a variable-speed, 75-kW rotary screw air compressor. Although compressed air consumption is currently running at between 5 and 25 m<sup>3</sup> per minute, the decision was nonetheless made to install two identical compressors. This means that one machine is always redundant.'



## Compressed Air Flow Measurement VP Instruments - Application Note

errit Renting (Maintenance Technician at Kikkoman) adds, 'An advantage of working with two identical machines is continuity, even if one compressor fails or if maintenance work is being carried out. Thanks to the fully automated pressure safety system installed, less blower air is now used at the fermentation tanks at pressures below 5.4 bar. And with Ingersoll Rand's special-purpose IntelliFlow flow controller installed, the entire process now operates at a minimum pressure of 5.8 bar. Previously, this lower operating limit was 7.5 bar. So this saves us a lot of energy.'

### Usage

In order to monitor compressed air consumption throughout the entire plant, VPInstruments installed air flow meters with diameters ranging from 25 to 76 mm (1 to 3") in each department. Pascal van Putten (Managing Director at VPInstruments) explains, 'All these air flow meters take readings on a continuous basis and transmit their data to the VPVision visualization system installed in the compressor room. The screen displays real-time compressed air consumption data for each department. Pie charts illustrate which loads are consuming the most air.'

Renting adds, 'The maintenance department investigates whether there are any compressed air leaks in the system during off-peak hours. Depending on the severity of any leaks found, a decision is made as to whether to take immediate action or to postpone repair. Sealing leaks immediately isn't always an option, as there are parts of the production process that are always in standby. For example, line pumps and bottle checkers.'

### Energy Savings

Meerman adds, 'Since opening this plant in 1997, **we've succeeded in cutting energy costs by 32% for compressors alone! We're currently using six air flow meters and soon we'll have eight – one in each department. In order to monitor the process properly, it's important that we can address each factory department individually. This wasn't initially possible.** Back then, we were using one main air line with multiple branches to each department, which made monitoring particularly tricky.'

Now we have a distribution station that splits supplies properly. If maintenance is being performed in a particular department, then that section can be temporarily shut down. We're currently investigating whether options exist to shut off temporarily non-operational departments from the compressed air system altogether. This would reduce consumption even further.'

### Benchmark

Kikkoman Corporation's worldwide production facilities are benchmarked every year with regard to energy savings in order to minimize the energy used per litre of soy sauce produced. The Netherlands scores well as a production facility. 'We have to remain alert to maintain this level in the future. Especially when expanding operations in the future. We'll be examining every new system very critically with regard to its energy consumption levels,' Renting states.

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