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MACHINING PROJECT SHOWS CORRECT COOLANT CHOICE SAVES ENERGY

A growing number of manufacturers are realising substantial financial and environmental benefits from the employment of sustainable business practices. Indeed, one aerospace manufacturer recently found a considerable margin for saving energy in CNC machining processes, with correct coolant selection.

The OEM took advantage of a sustainable manufacturing initiative sponsored by the US Air Force and applied one of its flexible machining cells to the project. It aimed to discover just how much energy could be saved in machining a titanium 6Al-4V sample aircraft part designed with deep pockets, typical of the sector. The trial took place using a 10-year old horizontal machining centre.

Using a power meter, researchers measured the effects of various attempts to save energy during machining. They discovered that strategic choices relating to tools, coolant, programming and parameters can all combine to reduce energy use by 73% of what the plant's established processes would usually consume.

The Air Force funded the study to prepare suppliers for potentially higher energy costs in the future and among the main areas of focus was the effectiveness of through-tool coolant delivery.

Standard solid carbide end mills using only flood coolant were run against otherwise identical end mills that had been modified to deliver coolant through ports near the flute tips. Both methods used TRIM® MicroSol® 585 from Master Chemical which was selected against four competitor coolants following trials.

Cutting and non-cutting criteria
While tool life would be the determining factor, the chosen coolant had to address numerous secondary issues. For instance, it had to minimise mist and eliminate any sticky residue that might cause the titanium chips to adhere to the machine tool.

Each candidate fluid was run at 6% concentration, diluted in de-ionised water. After the machining tests were completed, laboratory tests were run to compare the fluids for these non-cutting functions along with health and safety concerns, bio-stability and sump life.

Once TRIM® MicroSol 585 was declared the superior option, research continued and through-tool delivery provided measurably superior tool life in multiple ways. Not only did nominal tool life improve, but the wear from flute-to-flute on the same tool was more consistent.

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This consistency effectively extends the tool life advantage, because if a tool can be trusted to wear predictably, then it can be trusted to remain in-cut longer. The team's testing of through-tool coolant demonstrated tool life improvements of as much as 30%.

"Coolant is vital to tool life and selecting the correct chemistries will immensely improve tooling performance," says Monte Dhatt, Global Aerospace Manager at Master Chemical. "Of course, a proper plant audit should be conducted before selecting the correct coolant for each individual application."

Through-tool coolant can be recommended for titanium when it helps with chip clearance issues. Insert-based systems that allow coolant to get very close to the cutting edge are preferred as they facilitate higher metal removal rates in face milling.

According to Master Chemical, coolant selection considerations should include the type of machine, the materials being cut, operations, cycle time, tooling type, quantity of machine tramp oil, water type (RO, DI, hardness), operator contact, foam and filtration.

"Through-tool operations typically encompass high pressure in the range of 1000 – 1500 psi," says Mr. Dhatt. "With high pressure you want to use coolants that are low foaming and can break the foam quickly, otherwise spill-overs can occur."

He continues: "Modern machines are equipped with sensors that will stop the machine in mid-cycle when it senses a spill-over. This can be very costly as it can scrap a part in mid-cut. Typically, synthetic and semi-synthetic chemistries will provide the best foam control."

Energy savings and much more

The machining process that combined these improvements with others relating to cutting tools and programming techniques consumed 0.32 kW hr/in^3, a 73% reduction in energy from the way the plant machined parts before the sustainability research began. Now, as a result of these findings, various existing parts have been re-programmed for cycle time savings. Such savings provide for sustainability in a number of ways.

While the term usually implies lowering energy use, keeping a job commercially sustainable involves holding costs low enough that the part remains in production. These aims are not contradictory. The findings of the sustainability testing are particularly promising for the aerospace manufacturer, not only for energy reduction, but also for cost reduction and increased capacity resulting from cycle time improvements.

Although Master Chemical admits that before the study it did not consider energy savings specifically during its development process, the company always preaches the overall cost of correct coolant selection and coolant management.

"Under this philosophy, costs savings – including energy – are always something we can measure for customers," says Mr. Dhatt. "Moving forward, this particular customer is now using TRIM® MicroSol® 585XT which is an upgrade to the original formula. Foam and sump life were improved to address minor shortfalls identified in the study. In fact, the success story allowed us to establish a corporate contract with the company and expand the use of TRIM® MicroSol® 585XT in many of its other facilities.

While it is particularly well suited to machining and grinding mixed metals, TRIM® MicroSol® 585XT has proven to be an exceptional coolant for cutting titanium alloys. Indeed, for another customer it eliminated a host of problems experienced with alternative fluids. These included bad smells, excessive carry-off, smoking and seal damage.

Approved by Airbus, Boeing, Pratt & Whitney (United Technologies), Bombardier and Safran, TRIM® MicroSol® 585XT is a high lubrication, semi-synthetic micro-emulsion coolant. It provides excellent coolant and mechanical lubricity. Fast wetting gets the fluid to the point-of-cut quickly and ensures workpiece and chips are coated thoroughly for superior corrosion protection.

Finally, it's worth addressing the issue of boron, which is typically included to assist with ferrous corrosion inhibition on parts and machine tools. Although TRIM® MicroSol® 585XT contains elemental boron, any boric acid has been fully reacted in the formula so there is no free boric acid which is an item of concern for some manufacturers.

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