PROTOMATIC

White Paper – Case Study

MACHINING WITH CO_2 TECHNOLOGY – MEDICAL

Machining with reclaimed Carbon Dioxide (CO_2) addresses two critical issues in the medical machining industry. The first issue is the need to machine components that are designed to be used inside the human body where part contamination introduced during the machining processes is prohibited. The second issue addresses the need to hold ever tighter tolerances while machining plastic medical components.

This paper addresses the benefits of CO_2 as witnessed by our company, Protomatic, Dexter, Michigan, USA.

Background

We discovered that in order to meet a manufacturing tolerance of 0.001 +/- 0.0002 inches in a very soft Delrin plastic part, our normal machining techniques using flood coolant were barely adequate. Since this was a Class 2 medical component of an assembly that is to contact the human body, an additional customer requirement was that it could not come in contact with any chemicals. These contaminants introduced during the machining process have the potential to migrate from the part to the patient's body.

Delrin is a relatively porous plastic that absorbs chemicals and microscopic fines all too well. No manner of washing or cleaning would remove the imbedded oils or possible small metallic fines that the cutting fluid introduces into the part.

As we dry machined the wafer like components to avoid contamination, we found that the work piece would climb into the tool, compromising the finish and tolerance control. Even at very slow cutting speeds, the resulting part thickness was unpredictable, not to mention the extraordinarily high and uncompetitive cycle times.

A cold gun system offered negligible improvement and still had the potential to introduce oils or dust particles into the material.

Solution

During our investigation program to resolve this problem, Protomatic engineers discovered numerous papers relating to machining with gases, specifically compressed carbon dioxide or nitrogen. We were familiar with the use of nitrogen for machining purposes and have used it with limited success.

However, the problem with nitrogen is related to uncontrolled part temperature in that if the exposure to the nitrogen was too long by even a split second, the part would become brittle and not machine predictably. Nitrogen converts (boils) from a liquid to a gas at -196^0C (-321^0F). It was difficult to control the exposure time on the work piece. Even a slight deviation in exposure time dramatically changed the machining characteristics of the plastic.

On the other hand, CO_2 converts from a liquid to a gas at -78^0C (-109^0F). This higher operational temperature made exposure time less critical. Using CO_2 as the machining fluid created a stable machining condition and eliminated washing processes, ineffective as they were. The units

available in the market for delivering CO_2 to a cutting tool addressed the temperature control of the work piece. Cycle times were reduced while part quality became very consistent.

Added benefits

A clear benefit was the elimination of messy metalworking fluids at the machine tool.

Another benefit is that using CO_2 for machining is a very green initiative. While CO_2 is recognized as an environmentally undesirable greenhouse gas in the atmosphere, the CO_2 used in machining processes comes from 100% recycled sources just as it does for carbonated beverages in restaurants. CO_2 is a by-product of not only numerous natural processes, but also many industrial chemical manufacturing processes.

When it is a highly purified by-product of an industrial process it can be captured as a valuable waste stream creating a revenue flow for the chemical manufacturer to offset their fines as a CO_2 generator. As a user of recycled CO_2, we are not recognized as a CO_2 generator.

The downside

Machinists who are accustomed to using flood coolant, available at the flick of a switch or a simple command in the machine tool programming find that incorporating CO_2 delivery to their machining process is awkward. Once the setup becomes routine, however, objections subside.

Frequently, purchasers of new machine tool equipment that incorporates through spindle coolant capability for high pressure flood systems find that high end CO_2 delivery systems are available and can be integrated with the machine programs.

Note: Protomatic does not manufacture the CO_2 equipment or nozzles for use with a machine tool. Equipment is available from Cool Clean Technologies (www.CoolClean.com)

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www.ProtomaticMedical.com

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