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Project Summary

Novel Vapor-Deposited Lubricants for Metal-Forming Processes

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This report gives results of a laboratory study of the feasibility of using vapor-phase lubrication to lubricate industrial metal forging dies. It gives results of six tasks conducted during the study and discusses the potential production and environmental impact of the process. If a vapor lubrication system can be developed for general industrial use it can significantly reduce the volume of forging lubricants required by present industrial forging operations. The laboratory results indicate that it may be possible to reduce potential air pollution emissions from forging using vapor lubrication by as much as 85%. This would be accomplished by using 85% less lubricant volume during metal forging.

This Project Summary was developed by EPA's Air and Energy Engineering Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering Information at back).

Introduction

The forging and shaping of metal parts is one of many metal fabricating processes that may generate emissions of volatile organic compounds (VOCs) and hydrocarbons. In typical metal forming operations hot metal is squeezed in dies to produce metal shapes in the form of the die cavity. This process may require many intermediate forming and shaping steps using successively more accurate dies to reach the finished product. A key aspect of these shaping steps is the lubrication of the dies and metal parts to allow easy release of the part from the die. The used lubricants frequently result in emissions containing VOCs and potentially toxic metal to the atmosphere.

This report presents the results of a Phase I study that investigated the feasibility of using vapor-phase lubrication for industrial metal forging dies. It presents the results of six tasks conducted during the study and discusses the potential production and environmental impact of the effectiveness of the process. A vapor lubrication system developed for general industrial use could significantly reduce the volume of forging lubricants required by present industrial forging operations.

The project proposes to use a vapor-phase polymer film to lubricate forging dies in their closed position. An injection device allows lubricant vapor to be applied automatically through passages in the flange areas of the die. This eliminates large volumes of liquid die lubricants and the resulting emissions typically generated during this operation.

Project Plan

Six tasks were performed during the project. Each was designed to produce vital elements and data for a future pilot scale unit. The six tasks were to:

- Establish a fully operational, laboratory scale vapor-phase lubricant delivery system (LDS).
- Formulate lubricants and evaluate the lubricity of the vapor-deposited polymers using the ring compression test.
- Forge parts using conventional lubricants to provide baseline data.
- Modify the forging die to permit vapor-phase lubrication.
- Forge five parts using vapor-phase lubrication in a modified die.
- Quantitatively compare the emissions from vapor-deposited lubrication with those from the conventional oil-based lubrication system.

Emission Results

The volume of lubricant used during each experiment was determined qualitatively by the metal flow and release properties exhibited by each technique. Metal flow is defined by the interface friction factor (m value) which is a measure of metal flow within the die. Release properties are defined by the relative ease with which the part can be removed from the die. It was assumed that all lubricant used during each experiment was volatilized to the atmosphere. This represents the worst case scenario for the process. Table 1 summarizes the results.

Conclusion

Although this project included a limited number of experiments, it did show that vapor-phase lubrication is feasible for metal forging. It can also result in a significant reduction of potential emissions to the atmosphere. The process could reduce emissions from forging and casting operations by as much as 85%.

The project represents only the first step, laboratory feasibility, of the development program for vapor-phase lubrication. Significant research and development still remains, including die lubrication system design and lubricant formulation development.

Table 1. *Average Emissions and Forging Parameters*

	Conventional Lubrication	*Vapor-Phase Lubrication*
Average block and finish per part, ml	*76*	*11.3*
Average forging force, ton (kN)	*75 (667)*	*75 (667)*
Average forging time, sec	*60*	*60*

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The complete report, entitled "Novel Vapor-Deposited Lubricants for Metal-Forming Processes," (Order No. PB 87-227 351/AS; Cost: $11.95, subject to change) will be available only from:
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