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Project Summary

Engineering Evaluation to Examine Air Pollution Control Technology Used in Foreign Practice of Steelmaking

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A study was conducted to determine if technology used to capture and control fugitive dust emissions in the foreign practice of steelmaking is superior to that in use domestically. Foreign technology was compared to that in use domestically. Where apparently superior technology was identified, a feasibility study was performed to show the technology's domestic applicability.

Roof-mounted electrostatic precipitators (REPs) were identified as potentially superior technology. Using engineering data from an existing U.S. basic oxygen furnace shop and engineering design details for a Japanese supplied REP, costs of retrofitting the technology to an existing plant were estimated along with energy consumption, building modifications necessary, utility and wastewater treatment needs, and expected performance.

A visible emissions evaluation program was conducted in a Japanese steelmaking plant to determine the effectiveness of REPs in capturing and controlling fugitive emissions. REP electrical performance data obtained during this program and dust characteristics data from three fugitive dust sources in steelmaking operations were input to an electrostatic precipitator (ESP) computer model, and estimated performance was calculated. Good agreement was obtained between the actual measured performance of the REP and the computer predicted performance for the source where the evaluation program was performed.

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 purpose of this project was to perform an engineering evaluation of fugitive emission control technology in use in Japan and Western Europe, and (where judged to be superior to domestic technology) to show the foreign technology's applicability to domestic steelmaking practice. In evaluating foreign technology, emphasis was to be given to technology applicable to basic oxygen furnace (BOF) steelmaking. Following identification of apparently superior technology, on-site test programs to measure control effectiveness were planned for two sites.

Both foreign and domestic technologies were evaluated on data gathered by a literature search and plant visits. Five plants were visited in Western Europe and 12 plants in Japan. Technology and performance were compared between three recently constructed U.S. BOF shops and the foreign facilities. Based on these comparisons, only one foreign technology offers substantial performance effectiveness improvement with significantly reduced energy

consumption: roof-mounted electrostatic precipitators (REPs). Two other technologies were identified as offering some improvement in capture and control effectiveness when applied to a specific furnace type or a furnace enclosure: an automatic sampling lance (which eliminates the need to turn down a BOF vessel to get a metal sample); and compressed air curtains (to prevent leakage from viewing ports in a furnace enclosure).

A feasibility study was performed to determine the applicability of REPs to existing domestic BOF fugitive dust sources. Among the factors considered in the feasibility study were changes needed to existing plant facilities, estimated cost to modify the old facilities and add the new equipment, and the expected performance of the REPs.

Due to the difficulties in securing permission to test in foreign facilities, on-site performance was evaluated in only one plant. The desired site for evaluation was a BOF shop with REPs. Permission to test in BOF shops could not be obtained from the plants' owners. A visible emissions performance evaluation was finally arranged in an electric arc furnace steelmaking shop with an REP.

Data obtained during the performance evaluation was used in conjunction with an ESP computer model to predict performance of REPs on other fugitive dust sources in iron and steelmaking.

Summary and Conclusions

The two categories of systems for BOF secondary emissions capture and control seen in the foreign plants were based on: (1) local hooding only, and (2) local hooding plus partial building evacuation.

Plants with only local hooding predominated for the plants visited. In respect to the performance or capture capability of the local hooding applications, the best systems observed captured virtually all of the secondary emissions. The method of estimating capture efficiency was subjective, but best performance for all secondary emission sources was in the range of 90–100 percent capture.

While the partial building evacuation systems for furnace emissions were not in the majority, in several situations, such installations may offer advantages over the use of only local hooding. In particular, the use of REPs with no fans or minimal fan assistance, and therefore no significant energy costs, may be a cost effective alternative to complete reliance on local hooding connected to fabric filters.

The particulate collection device in most common use for secondary emission control systems is the fabric filter. Scrubbers and ESPs were used in only a few of the plants visited.

Based on performance observations and design data, the Italsider Taranto Works and Nippon Steel Yawata Works were selected as the plants with the best overall secondary emission control systems for top-blown furnaces in Western Europe and Japan, respectively.

A comparison of visible emissions evaluation data and engineering design data for the Kaiser Steel Fontana BOF shop (a new U.S. plant completed in 1978 with similar control systems) with data obtained during visits to the Italsider Taranto Works and the Nippon Steel Yawata Works suggests that the technology in use in these plants is equivalent.

The only foreign bottom-blown facility visited was Kawasaki Steel's Chiba Works. Comparison of hood capture effectiveness estimates for furnace secondary emissions between the Chiba Works and Republic Steel's Q-BOP at South Chicago indicates that the Japanese plant capture is at least as good or better. Given that furnace emission escaping capture at the Chiba Works furnace enclosure are further subject to capture in the REPs, the implication is that overall effectiveness is better at the Chiba Works than at Republic Steel.

No REPs are in use in the U.S. A feasibility study was conducted on the applicability of the technology to a typical U.S. BOF shop. For a typical facility which contains two BOF furnaces of 273 tonne (300 ton) capacity each, the estimated cost, delivered and erected on site is $3,020,000 or 60 percent of the estimated project cost. The remaining costs are absorbed primarily by structural reinforcement and modification of the existing BOF building. The total estimated project cost is $5,010,000. Estimated annual operating costs are $654,000. (All costs are estimated in third quarter 1982 dollars.)

The existing BOF building chosen for study would require extensive bracing and reinforcement to sustain the loads imposed by the REPs, primarily against wind loads at right angles to the building aisles. A computer analysis was performed on the existing BOF building. At crosswind speeds of 100 mph (161 km/hr), drift of the structure may be a problem which requires further structural analysis.

The critical phase of furnace operation with respect to REP performance is hot metal charging. Using emission factors and several assumptions, the inlet concentration during hot metal charging is estimated as 0.96 g/acm (0.42 gr/acf), giving an estimated outlet concentration of 0.082 g/acm (0.036 gr/acf) where only one REP receives the fumes. The range of concentrations estimated to produce 20 percent opacity at the REP discharge is 0.112–0.222 g/acm (0.049–0.097 gr/acf). Therefore, it appears that the REP installation can achieve discharges of less than 20 percent opacity during hot metal charging. A number of assumptions were necessary to make these performance estimates. It is important to verify the validity of some of these assumptions prior to proceeding with an installation.

A visible emissions performance evaluation was made on an REP applied to a Japanese electric arc furnace (EAF) steelmaking shop. The visible emissions performance data showed 95 percent of the 6-minute average opacities were 6 percent or less, with less than 1 percent of the averages exceeding 10 percent opacity. This performance is relatively good, but not quite as good as required for compliance with the proposed NSPS for EAF building discharges; i.e., no reading exceeding 6 percent opacity. Analysis and comparison of the Japanese furnace operating practices to U.S. practice suggests that the Tokyo Steel practice provides a greater potential for fugitive emissions and, therefore, represents a more difficult control situation than would be typical of a U.S. plant at present. Operator training, revisions to the furnace offtake duct design, and adequate operating practice information at the time of REP design are potential means for improving the REP performance.

Subsequent to the visible emissions performance evaluation at the Japanese EAF plant, a study was undertaken to determine the applicability of the EPA/Southern Research Institute computer model of ESP to the REP. REP electrical data and EAF dust characteristics data were used as model inputs, and REP efficiency and stack opacities were computed. The computer model predictions were in good agreement with previously measured performance. Performance was predicted for other

steel plant sources using dust characteristic data appropriate for those sources.

Results show that the ESP computer model can be useful in investigating ESPs applied to industries other than coal-fired boilers. The model study suggests that an REP can be equally effective when applied to BOF fugitive emissions and blast furnace casthouse fugitive emissions. Additional tests of the model for various sources in the iron and steel industry are necessary to provide the same level of confidence in the model as exists in the utility industry. Such tests should include measurement of *in-situ* electrical resistivity and simultaneous measurement of inlet and outlet particulate size distribution and mass loading.

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The complete report, entitled "Engineering Evaluation to Examine Air Pollution Control Technology Used in Foreign Practice of Steelmaking," (Order No. PB 85-216 596/AS; Cost: $25.00, subject to change) will be available only from:

National Technical Information Service
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