

TECHNICAL REVIEWERS' COMMENTS

LRC-LXX(70)-A: "Agglomeration and Ash Deposition Management in Fluidized Bed Combustion"

Submitted by: Microbeam Technologies, Inc.;
Request for: \$50,000; Total Project Costs: \$300,000;
Project Manager: Margaret Laumb;
Project Duration: Two Years.

1. OBJECTIVES

The objectives or goals of the proposed project with respect to clarity and consistency with Industrial Commission/Lignite Research Council goals are: 1 - very unclear; 2 - unclear; 3 - clear; 4 - very clear; or 5 - exceptionally clear.

Reviewer 10-10 (Rating: 3)

The goal of the project is defined, which is to develop a tool to enable reliable use of lignite in FBC systems (i.e., systems other pulverized coal-fired units). The increased use of lignite is consistent with NDIC/ LRC goals.

Reviewer 10-11 (Rating: 4)

The goal of this project is to develop a predictive tool that can be used by operators of fluidized bed combustion (FBC) Power Plants to minimize/control/eliminate the agglomeration and fouling problems that occur in those plants. These problems are especially severe in units that fire North Dakota lignite because of its high sodium content. A reasonable fraction of the work in this total project will be focused on issues related to North Dakota lignite. Success in the project should enhance the competitive position of North Dakota fuels in FBC power plant applications.

Reviewer 10-12 (Rating: 5)

The proposed project objective is to incorporate agglomeration and ash deposition mechanism into a computer-based tool that can be utilized by FBC system operators to manager ash-related problems through the selection and optimization of fuel, bed materials, additives, and operating conditions. The tool will be designed to include information on the potential of agglomeration and deposition on heat transfer surfaces as a function of bed materials, additives, fuels and operating parameters. The objectives are exceptionally clear and consistent with NDIC goals to promote and maintain use of NDL and lignite jobs.

2. ACHIEVABILITY

With the approach suggested and time and budget available, the objectives are: 1 - not achievable; 2 - possibly achievable; 3 - likely achievable; 4 - most likely achievable; or 5 - certainly achievable.

Reviewer 10-10 (Rating: 2)

I'm not convinced the approach will work. The environments under study are complex systems with many physical interactions and chemical reactions that, in my opinion, are too complex for a simple Excel spreadsheet model. One is dealing with a complex system of chemistry, mass transfer, heat transfer, and fluid dynamics. There are others developing tools (or, as some have claimed developed tools) like that proposed where they are integrating computations fluid dynamics (CFD) modeling along with various chemical reaction programs (e.g., FactSage).

In addition, I question the usefulness of the bench-scale testing. I do not doubt that Microbeam has analyzed deposits from full-scale systems and performed 'forensic' analyses to assist the industry. However, I do not believe bench-scale testing can generate samples that are representative of that found in full-scale systems. I have seen too many bench-scale deposition results (e.g., drop-tube reactors, sintering devices, etc.) that do not match pilot-scale testing, which can also have difficulties in being representative of full-scale systems.

Reviewer 10-11 (Rating: 3)

It is very hard to predict whether the tool that will be developed will be useful to plant operators on a day-to-day basis. Its use should be able as a minimum to suggest general approaches to solving operating problems, but many of the problems encountered are a strong function of local design geometries, which may or may not be properly represented in the models used in the ultimate product of this work.

If validation is successful, this tool may be useful in establishing design criteria useful in the design of future units.

Reviewer 10-12 (Rating: 4)

The proposed objectives are most likely achievable with the budget and time suggested.

3. **METHODOLOGY**

The quality of the methodology displayed in the proposal is: 1 - well below average; 2 - below average; 3 - average; 4 - above average; or 5 - well above average.

Reviewer 10-10 (Rating: 2)

The methodology is below average for many of the reasons identified in Item #2. Also, there is a breakdown of tasks with a general discussion; however, there are no real details on how the tool will be developed, just generalizations.

Reviewer 10-11 (Rating: 4)

The project is very well organized, consisting of reviewing the existing data base of agglomerated samples from FBC units, collecting new analytical on additional samples, developing a predictive tool that relates fuel properties and operating conditions to agglomerate formation and deposition which fouls heat transfer and other surfaces, and finally attempting to validate that tool.

Reviewer 10-12 (Rating: 5)

The quality of the methodology displayed in the proposal is well above average. The proposer does an excellent job in relating the technical and management facets of the project.

4. **CONTRIBUTION**

The scientific and/or technical contribution of the proposed work to specifically address Industrial Commission/LRC goals will likely be: 1 - extremely small; 2 - small; 3 - significant; 4 - very significant; or 5 - extremely significant.

Reviewer 10-10 (Rating: 3)

If the project were successful, it would be significant to the North Dakota lignite industry. If successful, the project would address the NDIC/LRC goal of increasing or maintaining lignite usage

Reviewer 10-11 (Rating: 4)

Success in this work will be based on achieving a mechanistic understanding of agglomeration formation as a function of fuel properties and operating conditions. It will help operators of North Dakota lignite-fired FBC plants operate their existing units with fewer agglomeration and fouling problems and help designers of new units develop plant designs that are less likely to have operating problems.

Reviewer 10-12 (Rating: 3)

The scientific and technical contribution of the proposed work will most likely be significant while specifically addressing NDIC/LRC goals.

5. **AWARENESS**

The principal investigator's awareness of current research activity and published literature as evidenced by literature referenced and its interpretation and by the reference to unpublished research related to the proposal is: 1 - very limited; 2 - limited; 3 - adequate; 4 - better than average; or 5 - exceptional.

Reviewer 10-10 (Rating: 5)

The PI is well qualified. He has been working in the field of ash chemistry for many years and has a proven research record.

Reviewer 10-11 (Rating: 4)

The descriptions of the formation mechanisms for several types of agglomerates demonstrate that the PIs have a clear understanding of the problems. That information provides the PIs with the bases for identification of the additional data that should be collected during this project.

Reviewer 10-12 (Rating: 5)

The PI's awareness of current research activity and published literature is exceptional. Dr. Benson, Ms Laumb and A. Ruud are accomplished and recognized professionals in their fields. Their discussion of agglomeration and deposition is excellent. In addition, they provide extensive references.

6. **BACKGROUND**

The background of the investigator(s) as related to the proposed work is: 1 - very limited; 2 - limited; 3 - adequate; 4 - better than average; or 5 - exceptional.

Reviewer 10-10 (Rating: 3)

The support staff for the PI appear to be well qualified.

Reviewer 10-11 (Rating: 4)

The work that the PIs have in analyzing agglomerates from a variety of units and their understanding of the phenomena involved is very appropriate for this project

Reviewer 10-12 (Rating: 5)

The backgrounds of the PIs' are exceptional.

7. **PROJECT MANAGEMENT**

The project management plan, including a well-defined milestone chart, schedule, financial plan, and plan for communications among the investigators and subcontractors, if any is: 1 - very inadequate; 2 - inadequate; 3 - adequate; 4 - very good; or 5 - exceptionally good.

Reviewer 10-10 (Rating: 2)

The management plan is lacking. There is a milestone chart but it does not contain any details. There is no indication of milestones, no details on the types of tests and when they are performed, no details on the case studies, etc. There is very little detail for a 2-year project.

Reviewer 10-11 (Rating: 4)

The management plan is very organized with appropriate meetings scheduled with and reports provided to sponsors for each quarter and completed Task. The by Task schedule is clear. The budget breakdown is for the overall project but is not broken down by Task as described in the proposal.

Reviewer 10-12 (Rating: 4)

The project management plan is very good. The SOW and project schedule could be enhanced with additional levels of detail.

8. **EQUIPMENT PURCHASE**

The proposed purchase of equipment is: 1 – extremely poorly justified; 2 – poorly justified; 3 – justified; 4 – well justified; or 5 – extremely well justified. (Circle 5 if no equipment is to be purchased.)

Reviewer 10-10 (Rating: 5)

There is no indication in the budget or proposal of equipment being purchased.

Reviewer 10-11 (Rating: 5)

No equipment is to be purchased for this project.

Reviewer 10-12 (Rating: 5)

NOTE: Reviewer10-12 provided no comments.

9. **FACILITIES**

The facilities and equipment available and to be purchased for the proposed research are: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – notably good; or 5 – exceptionally good.

Reviewer 10-10 (Rating: 3)

As previously discussed, I do not think the bench-scale system is adequate for the testing. However, database compilation and modeling is computer based and I am sure that the computers are adequate.

Reviewer 10-11 (Rating: 4)

All of the equipment required for this project is now in place. Microbeam Technologies claims to have experience with all of this equipment.

Reviewer 10-12 (Rating: 4)

The facilities and equipment identified are notable good.

10. **BUDGET**

The proposed budget "value"¹ relative to the outlined work and the financial commitment from other sources² is of: 1 - very low value; 2 - low value; 3 - average value; 4 - high value; or 5 very high value.

Reviewer 10-10 (Rating: 3)

At the time the proposal was prepared, there was only one industry sponsor so NDIC would be providing 50% of the funding; therefore, the value to NDIC is average. If the project gets full funding and if the project can be successfully performed, the value to NDIC would be high.

Reviewer 10-11 (Rating: 4)

The total planned budget for the two-year project is \$300,000. The request to the NDIC is for \$50,000 with the balance to be raised from other sponsors. MDU has committed \$50,000. Discussions are being held with other potential sponsors. NDIC funds will be utilized primarily for work related to North Dakota lignite. The percentage of NDIC funding may range from a low of 16.7% to a high of 50% if MDU is the only outside sponsor, of what would obviously be a much smaller scope project. The overall project is a good one and even a reduced scope project focused on North Dakota lignite would be of high value to NDIC.

Reviewer 10-12 (Rating: 4)

The proposed budget is of high value. The equipment and facilities are notably good and the PIs are exceptional.

OVERALL COMMENTS AND RECOMMENDATION:

Please comment in a general way about the merits and flaws of the proposed project and make a recommendation whether or not to fund.

Reviewer 10-10 (Rating: FUNDING MAY BE CONSIDERED)

I recommend that funding be considered contingent upon: 1) details on the tool development be provided so NDIC can review the methodology, and 2) all five of the industry sponsors be signed up. As discussed earlier, I question the approach (bench-scale testing and an Excel-based tool) and would have recommended do not fund if it were not for the PI's reputation and past research record. Maybe if there were more details on the methodology the proposal would be easier to review and a make a recommendation. There is a lengthy background on ash deposition but very little on methodology details. If there would have been as much effort put into the methodology section as the general background section, the overall proposal would have been much better.

Reviewer 10-11 (Rating: FUND)

The project should be funded.

The project is well organized with well defined tasks, a good management structure, and well-qualified personnel. The objective is to develop a tool that can be used by FBC plant operators to identify optimum operating conditions to avoid agglomeration and fouling problems. If the use of the tool is successfully validated resulting in fewer operating problems, it could be used in the future as a design tool to reduce problems in future units.

¹ "Value" – The value of the projected work and technical outcome for the budgeted amount of the project, based on your estimate of what the work might cost in research settings with which you are familiar.

² Financial commitment from other sources – A minimum of 50% of the total project must come from other than Industrial Commission sources to meet the program guidelines. Support greater than 50% from Industrial Commission sources should be evaluated as favorable to the application.

One minor issue that I had with this proposal is that it does not provide an explanation of how success in this project will improve power generation efficiency.

Reviewer 10-12 (Rating: FUND)

The exceptional backgrounds of the PIs are strengths of the proposed project. In addition, the contribution of MDU and potential for application at Heskett are significant. Many of the merits of this proposal are discussed previously.

The flaws and weaknesses of this proposal include the lack of additional detail in the SOW and milestone chart, limited application in the NDL industry, and a question of uniqueness of the study. The milestone chart/project summary could be more easily understood and related to the SOW, tasks and budget if two additional levels of detail were provided. The PI/s previous work is an asset to this proposal. However, is the proposed work unique or re-packaging of old work?

In spite of potential questions and weaknesses, funding of this proposal is recommended. Dr. Benson and colleagues have provided exceptional assistance for the industry and their expertise in this area is outstanding.