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IMPROVEMENT PROGRAM - 23L-5 RMA LINE

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INTRODUCTION
Since almost four months have elapsed since product introduction into the RMA Line, it is pertinent at this time to evaluate both process and equipment performance and arrive at a program for future improvement. The suggestions and recommendations to follow are those of the Technical Section. In those passages dealing with process, mechanical, and operational performance, an effort has been made to acknowledge the views of the appropriate groups. No doubt other items will become apparent in the future but it is hoped that these may be included later within the structure of the overall approach presented here and it is certainly expected that the "approved program" that will result from the discussion of this presentation will be expanded to include additional problems.

BASES FOR FUTURE STUDIES
In arriving at a program for future studies, a line of reasoning such as the following provides the bases for the subsequent recommendations.

1. The accomplishment of product processing by "remote mechanical means" is desirable and every effort should be made to preserve this principle of operation where the hazard warrants, and to compromise it only in accordance with the degree of hazard.

2. The achievement of reliable, reproducible, and non-hazardous operation will require that mechanical equipment give precise and reproducible performance for extended periods and be essentially free of maintenance problems.

3. The performance of the RMA Line to date, despite the conscientious efforts of all participating groups, has revealed a number of fundamental process, equipment, and operational weaknesses.

4. It is the belief of the Technical Section that the rectification of these weaknesses can be accomplished only by means of a carefully planned program having as its main objectives:
   a) the principles of operation enumerated in (1) and (2) above.
   b) the realization of program "X" production levels permitting a "stand-by" status for the RQ Line.

5. The execution of a planned improvement program will bring to light several "mental" hazards that will be common to all participating groups. First there will be the natural desire to execute rapid changes or improvements that may appear to offer an immediate solution but fall short of the objectives stated in item 4. Second, variations in performance may result in a feeling of optimism one week and a feeling of pessimism another with the intensity of application to objectives varying accordingly.
6. It is believed that such "mental hazards" can be minimized by close adherence to the objectives stated in item 4 above.

**RECOMMENDATIONS**

Appendix A enumerates the presently observed deficiencies and weaknesses of the RMA Line. No doubt, other weaknesses will be found. Those listed are believed to be of prime importance at the present time.

Appendix B presents recommended action to rectify the stated difficulties. Further details will no doubt be developed during the course of programming by the participating groups.

The recommended course of action has been divided into three phases, with only the first two of major concern here. These phases are described below.

**Phase I**

Based on the items described in Appendices A and B, a program should be drawn up acknowledging that most of the current production can be handled through the RG Line. This program should be supported by a balanced organization of personnel from the Separations Section and Separations Technology Unit whose function would be the achievement of improved performance and not immediate production. It is estimated that such a program, if properly supported, could be executed within the next six months and would result in a substantial divergence of RG processing to RMA at that time and the resumption of a normal "production status" for RMA.

It is further believed that the operational condition of RMA at that time could be considered "reliable and reproducible" but not necessarily "optimum". The extent to which it would approach an optimum condition will certainly depend on the success of the program and the results of the supplementary activities outlined in Phase II below.

**Phase II**

This phase, some of which could run concurrently with Phase I can be considered in three parts.

1. Activation of Task I.

2. Initiation of long-range improvement studies through a) experimental process and mechanical development and b) design studies of the RDA committee.

3. Based on such studies and accomplishments under Phase I, determine whether the achievement of "optimum" operation can best be accomplished through further modifications to the RMA Line or by revision to the RG Line.
Phase III

Acknowledging that the achievement of reliable and economical processing will require the execution of Phases I and II, it is nevertheless felt that one approach to this goal would be the availability of a new and much simpler scheme of chemical processing. Research and development efforts are being directed to this end with the conviction that the ultimate in simplicity and safety will require some process changes.

CONCLUSIONS

Several means have been considered for accomplishing RMA Line performance improvements rapidly and effectively. The above recommendations are premised on two main convictions:

1. That the quickest realisation of quality and quantity performance of the RMA Line will require some investment now of production capacity to permit evaluation of modifications required for program I production capacities, and

2. That if adhered to steadfastly and supported effectively the broad program presented should produce results acceptable to all participating groups.
Deficiencies known to exist in the RM Line equipment are listed below by Tasks:

**Task II**

1. Filter boats, when used as filters in the 231 Building, allow passage of precipitates around the sintered discs. Attempts to provide adequate seals by peening the discs at the edges have not been permanently corrective and the maintenance mechanic assigned to boat repairs has estimated that two more repairs might be the limit in correction of leaks by peening. The feasibility of welding the leaks is being investigated; however, previous attempts to weld were unsuccessful.

Gases are not now being drawn through the filter cake and filters in Task II as was originally intended. Gases are admitted to the furnace and allowed to contact the precipitate by diffusion. Cycle times are being increased as a result of this change and the shortest practical cycle has not yet been established. A program for solving the problems concerning RM Line boats should be established and given a high priority.

2. Difficulties encountered in the furnace gas-exhaust systems include:
   a. water back-ups from the aspirators occur,
   b. exhaust-line valves leak and allow water to back into furnaces,
   c. gas lines corrode badly, and corrosive products plug the exhaust lines, and
   d. adequate pressure differentials frequently cannot be obtained between the furnaces and the hood interior. Causes and/or suspected causes are:
      - Leaks at furnace door gaskets,
      - Leaks at ball and socket fittings,
      - Plugged lines or valves or leaking lines, and
      - Unsatisfactory aspirator operation.

3. Difficulties encountered with the HF and O2 supply lines which result in high maintenance costs and lost production time include:
   a. Liquid HF is frequently discharged into the furnaces,
   b. HF corrosion of valves and flow control equipment requires frequent maintenance or replacement, and
   c. HF back-ups to the oxygen lines and instruments cause excessive corrosion to the oxygen lines and instruments.
Task III

1. Boat to mixer dumping equipment holds up powder frequently. This results in the addition of chemicals and 70-58 in incorrect amounts to a large percentage of the runs.

2. The mixer's maximum capacity is 32.8 kg. Pu if powders contain small aggregates and have a bulk density of 1 g/cc. or less.

3. The mixer and/or crucible loading equipment creates segregation of some of the ingredients. The adverse affect on reduction yields cannot be given quantitatively but the cause should be corrected.

4. Mixer end-seals are difficult to adjust and maintain and powder losses through the seals are excessive. Inaccurate yield calculations result.

5. Equipment for adding recycle and 70-58 to the reduction charge is inadequate.

6. All of the above equipment is inadequately visible from Zone 1 and improper functions are not detectable during routine operation until the Task III process is completed.

7. Vacuum and purge valves do not operate dependable. It is possible that reductions in air occur and that pressures are lost during reductions due to these deficiencies.

8. Hood 13V which contains the vacuum system valves is too crowded to allow safe and easy maintenance of enclosed valves.

9. Equipment for cutting the can-crucibles assembly requires frequent and difficult maintenance.

10. Accuracy and dependability of the A.T.C. pressure gauges are questionable.

11. Interlocks which prohibit motion of the hood conveyor and thereby reduce production capacity should be reviewed and changed if necessary for attaining program "I" production rates.


13. The present material for the furnaces (Allegany-Ludlum V-36) is not available for furnace replacement.
14. The furnace design incorporates a knife edge on the furnace. This should be reviewed and redesigned before replacements are fabricated if a better scheme can be conceived.

15. To reduce the weight of crucible sent to recovery and decrease the absorption of 70-58, slip-cast crucibles should be used in RM Line reductions. The changes necessary to permit their use should be determined and their use considered.

Task IV

1. Furnaces.
   a. Inadequate contact between element and electrode exists, causing high current densities at points and subsequent damage to the element and electrode.
   b. Upper shielding and element spreaders should be simplified if possible.
   c. Nickel thermowells in furnaces 1, 3, and 4 crystallize and crack.
   d. Unseating of an O-ring frequently occurs when furnace bottoms are retracted.
   e. Contacts for furnace thermocouples are not adequately positive. This can result in improper temperature cycles and affect the purification and stability of the product.

2. Furnace bottom lifts can be (have been) damaged by raising them when the carriage in the hood is in their path.

Task V

1. The Beckman O₂ analyzer is not accurate with CCl₄ fumes in system.

2. Ventilation of the hood is not easily controllable, and pressure differentials between zones 3 and 4 vary widely.

3. The balance provided for weighing samples and turnings is not dependable. Inaccurate accountability results or unnecessary time is required to weigh on the in-line balances.

Task VII

1. Non-uniform coats have been detected. The cause has not been definitely established. It is currently suspected that increasing the number of coating cycles will correct this. If so, the increased nickel discharged to the heat traps will become a more serious problem.

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APPENDIX A (Continued)

2. Heat traps plug rapidly with nickel.

3. The degreaser has not been tried and deficiencies, if they exist, are not known.

4. Pressure charts cover such a wide range that accurate readings required for adequate control of the amount of nickel deposited are difficult, if not impossible to take. Undesirable variations in coating thickness from piece to piece result from this deficiency.

General

1. Ventilation

   a. Condensers for the air dryers have corroded rapidly due to high Cl concentration and low pH in the liquids condensed from the gases.

2. Conveyor

   a. Brush boxes are not adequately flexible for use with the existing bus bars.
   b. The arms are too weak for loads the conveyor should handle.
   c. Independent control of the clam shells and heat rotation is desirable.
   d. The carriage cannot be accurately positioned due to coasting after the power is turned off.
Appendix B

Presently Conceived Means for Correcting Deficiencies

Corrective measures for many of the deficiencies listed above are fairly well established. These are discussed briefly in this Appendix. In many cases, however, the solutions to problems concerning a piece of equipment are dependant on and must await demonstrated correction to interdependant equipment; for example, the amount of air leakage around furnace doors in Task II, the type of exhaust system in Task II and the type of filtering equipment in 231 or Task I are all dependant upon and affected by a decision which must be made on the use of filter or solid boats for Tasks I and II. Since additional work should be done before a final decision on boat type is made recommendations for the interdependant problems at this time would be difficult to make or confusing if all possible contingent corrective measures were enumerated. Therefore, to eliminate the major equipment operability deficiencies, a program should be established by Manufacturing and Technical personnel which recognizes the long range objectives and schedules the deficiency correction work on sound priority bases.

Some suggested corrective measures by Tasks are given below.

Task II

1. Before a choice is made between solid or filter-type boats, some additional information should be obtained.

   a. The production capacity of Task II equipment should be established for the two types of boats. Adequate time-cycle information exists for filter-type boats but additional information on time cycle vs. powder bed depth is needed to establish the production capacity possible if solid bottomed boats are used.

   b. If program "X" production rates can be accomplished with reasonable safety margins then flow the equipment diagrams and cost estimates should be made. With the information supplied by the program outlined above a selection of the type of boat to be used should be made.

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2. (See Item 1, Task II, Appendix A)

Deficiencies of the exhaust systems for Task II that are not affected by item 1 above can be corrected immediately and it is proposed that:

a. Monel or Hastelloy C tubing be installed from the fixed female gas-outlet fitting for a distance of 3 to 4 feet and MFP-10 tubing used from that point to the aspirators.

b. Elimination of ball and taper joints in the furnace to aspirator line is desirable but this is contingent upon the choice of the type of boat to be used. (See Item 3, Task II, Appendix A.)

3. The HF gas inlet tube should be extended to the back of the furnace to:

a. increase the temperature of the gas contacting the powder,
b. increase the HF concentration of the boat selected for the furnace, and
c. create a gas flow from the back to the front of the furnace.

To evaluate the benefits of the above changes and furnace gases should be sampled at different locations in the furnace under operating conditions and the HF/O₂ ratio determined in the boat-area of the furnace. If the HF/O₂ ratio is intolerable, baffles should then be added near the front of the furnace and on the peel bars as an air barrier and the furnace gases resampled. Several hydrofluorinations should then be carried out to evaluate the process results obtained.

The procedures recommended in Items 1 and 2 above are expected to:

a. Reduce the amount of metal pipe in the exhaust system subject to corrosion, subsequent line plugging and leaking,
b. Reduce or eliminate the effects of air leakage around the furnace doors on the hydrofluorination process, and consequently eliminate the need for an absolutely positive door to furnace seal, and
c. Increase the degree of conversion in a given time or decrease the time required for conversions considered adequate.

New types of HF control valves, aspirator and check valve assemblies and air ejector - filter - scrubber equipment are all being checked in mock-up equipment and the results of these tests will aid in establishing corrective measures for the other items listed under Task II deficiencies.
APPENDIX B (Continued)

Task III

1. Items 1 to 6 inclusive and 13 under "Deficiencies" Task III, should be corrected or adequately improved by a mixer assembly design and mock-up program currently in progress. Design plans include locating the boat dumping equipment, a tumbler mixer and mixer-to-crucible dumping equipment free from valves (except at the mixer closure) in a vertical line below the boat dumping station. Designs for chemical and recycle addition equipment are not firm but Los Alamos type equipment for the former is being considered.

2. Items No. 7, 9, and 10 should be corrected by 3 cycles of admitting argon to 100 lbs./sq.in. and venting to atmospheric pressure, admitting argon to ca. 100 psig and holding for leak checking. This procedure has been evaluated in mock-up equipment and its feasibility established. These procedures will retire the vacuum pump, pirani gauge, A.T.C., pressure sensing elements and recorders, and most of the valves in Hood 13W.

3. The remainder of the corrections will require some further consideration but should be scheduled for completion during the alterations recommended above.

Task IV

1. Tungsten expander rings recently installed at the bottom of the molybdenum heating elements appear to be satisfactory. Continued use of these should permit a firm decision concerning their desirability for permanent use. If satisfactory, similar expanders should be installed at the upper electrode, the wall-spreader assembly should be removed and the radiation reflector changed to its originally designed position for better heat distribution within the crucible zone.

An R.G. type heating element is being evaluated in R.M.B, furnaces. Its applicability appears feasible and its use is an alternate for consideration.

2. Stainless steel thermowells with nickel tips (two have been used satisfactorily) in furnaces 2 and 3 should be installed in furnaces 1 and 3.

Other problems are minor and should be scheduled for later consideration after more urgent Task II and III problems are solved.
Task VII

Experimental programs are being followed now in RM Line and experimental equipment for which data for firm recommendations on the position of the piece for coating, the number of coating cycles and initial gas pressures will be obtained. In addition, a coating procedure which substitutes nitrogen purging for high vacuum outgassing is ready for production testing.

Ventilation

Corrosive liquids in the dryer discharge-condensers are produced by the decomposition of carbon tetrafluoride in the recirculated air from the machining and cleaning hoods. An air flow as follows appears to be feasible and is being tried experimentally:

Room air ➔ Dryers ➔ Hoods ➔ E-4 Exhaust

An alternative, but more costly, corrective action would be to discharge hood atmospheres in which CCl₄ exists directly to the E-4 system and recirculate only purer air.

General Conveyor

W.P. Ingalls is currently working on designs for general conveyor alterations (Phase I) to correct the deficiencies given under this heading in Appendix A.