PLAINTIFF'S EXHIBIT FOS-181

TECH SERVICE

CONFIDENTIAL

Co-ordinated Research & Development Progress Report

3

FOSECO INTERNATIONAL LIMITED

APRIL, 1965.

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TECHNICAL DIVISION

MONTHLY REPORT - APRIL, 1965

STEELWORKS PROJECTS

1. SPECIAL DEOXIDANTS

Research

(a) Steel Castings.

Complex alloys based on the Briggs formulation have been added to a steel melt in both lump form and as powder protected by a mild steel container. The resulting ingots are currently being examined and compared with a control ingot deoxidised with aluminium and silicon.

(b) Steel Ingots.

The method of deoxidation in which aluminium is introduced to molten steel in mild steel containers has been extended to larger ingots. The method again proved to be satisfactory, the resulting ingots after sectioning being observed to be fully killed. These are now in process of metallographic examination for the purpose of inclusion assessment.

2. INCLUSION REMOVAL

Research

(a) Powder Blowing Gun.

Engineering modifications to the equipment have been made and consistent amounts of powder can now be delivered. A possible disadvantage is that rather high flow rates of the carrier gas appear to be necessary. The equipment has been temporarily transferred to the Foundry Department for preliminary assessment by treatment of molten aluminium.

(b) Tablet Additions to Mould.

Experiments in which molten steel is teemed on to fluorspar in an ingot mould have been extended to larger ingots. Assessment of these is in progress.

(c) Standard System of Inclusion Identification.

A comprehensive report dealing with the origin, effects and identification of non-metallic inclusions is being prepared. This will be available for reference in the Library and Metallurgical Service Laboratory.

4. DESIGN OF HOT TOPS

Research

Profex Mould Lining.

Nothing to report.

5. INGOT MOULD ADDITIVES

Research

(a) Stelotol 10 (Synthetic).

Further recipes based on pumice with various amounts of soda ash have been tested in bottom pour ingot moulds in our foundry. Examination is in progress of surface and microstructure of resulting ingots, and observations are being correlated with physical properties of recipes tested. A refractory powder that is completely solid at molten steel temperatures has also been tried, but with extremely poor results.

Our best recipe tested to-date is D.R.643. Results in the field indicate that this provides a cover similar to that obtained with Thermofin 50X and an ingot surface which compares favourably with that achieved with Stelotol 10.

(b) Stelotols 20 and 50.

Field testing of the high temperature version of Stelotol 50, D.R.659, is still awaited. An alternative means of igniting Stelotol 50 has been developed, using a special fuse which prevents extinction of combustion during application.

A visit has been made to Foseco S.p.A. and a Stelotol 50 recipe based on Italian raw materials formulated at the Marcallo Works.

(c) Coating of Metal Stream.

Nothing to report.

6. ANTI SCALE PAINTS

Research

(a) High Temperature Paints.

The search for a silicon carbide-free water-based coating is nearing conclusion. Bauxite had proved to be a successful base for such a paint, but because bauxite is a mineral of variable composition,

Ferrux formulations. Ferrux 40 is its closest match and cheaper formulations are also being assessed. Dry powder flowability of Ferrux recipes is reported to be inferior to that of Fonderit materials, and our product has to be spread over the metal surface. Experiments are in hand to improve this property by using additions of mica.

8. CONTINUOUS CASTING PROJECTS

Research

(a) Grain Refinement of Steel.

Nothing to report.

(b) Refractory Head.

Shelton Iron and Steel have contacted Foseco (F.S.) Limited, with a view to co-operation on this development.

(c) Refractory Erosion.

(i) Self Fired Refractory.

Following the conclusions of the Fulmer Research Institute reported in March, samples of both fused and dead burnt magnesite have been sent to B.C.R.A. for examination of contraction behaviour at 1700°C.

(ii) Coatings.

Tests in our foundry indicate that coatings containing green chromium oxide are fairly satisfactory. However, better results are obtained by the addition of calcium chromate and aluminium to the coating. Work continues.

(d) Steam Film Formation.

Practical experiments have been carried out using water containing various additives including substituted hydrazines and ureas to cool molten aluminium. Macro-examination of cast samples shows a marked reduction in length of columnar crystals at the surface cooled by treated water, indicating an improvement in heat abstraction. Work continues.

(e) Mould Lubrication.

(i) Oil Methods.

Experiments have been carried out in which rape seed oil has been applied to a metal surface at 1200°C. Observations indicate that the lubrication achieved with this product is entirely gaseous, and that olive oil may be a suitable alternative.

FOUNDRY AND WROUGHT DIVISION

1. PADDING

Research

Nothing to report.

2. SAND ADDITIVES

Research

Considerable data has been compiled on the effect of E.P.1898 on sands containing clays other than western bentonite. In general, little major variation in sand properties is apparent.

Of the polyacrylamides other than Bonaril 11 examined, Separan MP10 and Separan PG2 showed promise as anti-scabbing additives. All are manufactured by Dow. Data on relative costs of these materials is being obtained.

Only marginal differences in green properties are apparent when E.P.1898 is added as a solution compared with normal solid addition. Dry properties are worsened. Concentration of the solution has little affect. E.P.1898 appears to improve ~~the properties~~ of a mixture of old and new sand.

When added to a 14% clay slurry as used by Fords, E.P. 1898 increases the viscosity to an unacceptable extent.

Development

E.P. 1898 in Steel Foundries.

Progress with this product is considered to be very satisfactory. Some twelve British steel foundries are still continuing with trials aimed at achieving unit sand working; in some cases the maximum practicable addition of returned sand has been reached and these foundries are now able to calculate their possible savings using this E.P.

For the period under review, 147 cwts. E.P.1898 were ordered in the U.K. compared with 67 cwts. over the previous two months.

Anti Finning Additives. E.P. 2596 and D.R. 601.

Progress is slow and generally not very exciting with this project. It has been established that E.P.2596 is capable of reducing or eliminating finning on grey iron castings when used in oil sand cores: the same appears to be the case for D.R.601. Both materials, however, have given rise to a mottled cast surface appearance and as a result, the

3. INOCULATION

Research

An intensive programme of work has been carried out to establish a technique of inoculating cast iron in the mould. Various methods have been tried and assessed by measurement of chill reduction. Promising results have been obtained using tablets of paraffin wax containing ferro silicon introduced into the mould cavity and paper coated with ferro silicon inserted into down-sprue. Loose powdered ferro silicon introduced to the mould cavity has given variable and inferior results, and unsatisfactory chill reduction was obtained. When a technique has been established, it is proposed to extend the work to an examination of formulations devised by Short Term Development Department.

4. FLUX WASHING

Research

(a) Solid Filter.

Nothing to report.

(b) New Flux Washing Tank.

Extensive programme of work has continued. No advantage has been found by pre-melting hygroscopic sodium-free fluxes in the tank and it is unlikely that such formulations will be acceptable. Examination of non-hygroscopic formulations based on E.P.2074 is being made. Loss of magnesium from strong aluminium alloys which occurred when using this flux in the old flux washing process is unlikely to occur to the same extent in the new tank.

Development

The final results of trials carried out at B.D.A., Distington, with magnesite granules and Filtrox 1 in a flux washing crucible have now been obtained. The average inclusion counts of three trials is as follows:-

Filter only	17 oxide inclusions per field on three sections of extruded T bar.
Filtrox 1 and Filter together	15 oxide inclusions per field on three sections of extruded T bar.
This compares with normal material without special treatment.	37 oxide inclusions per field on three sections of extruded T bar.
Chlorine degassed metal but not filtered.	3 oxide inclusions per field on three sections of extruded T bar.

7. DEOXIDANT - FOUNDRIES

Research

Nothing to report.

8. DIE COATINGS

Research

Field trials of D.R's 655 and 656 have been arranged at Delta Diecastings.

9. COATINGS FOR SAND MOULDS

Research

The relative efficiencies of various binders for coatings are being examined and an apparatus to measure the abrasion resistance of coatings is under construction. A visit has been made to B.S.C.R.A. to observe tests in which ferro-static pressue is simulated by applying pneumatic pressure over the surface of metal in a mould. It is anticipated that our standard method for assessment of coatings can be further improved by this technique and a similar apparatus is to be constructed.

Development

Coatings based on Chromite Flour (DR.647, DR.648).

A number of successful trials have now been conducted and in all cases the results are equal to or superior to the equivalent zircon or chromite sands. It is hoped to broaden the scope of the trials and publish the information abroad, so that Foseco companies can take advantage of the present zircon shortage.

10. COREBINDERS

Research

Two field trials have been carried out with D.R.660, but so far no reports are available on breakdown properties of the sand. Cores produced were slightly friable and this may necessitate modifying the recipe. This project is being extended to include an assessment of all potential systems able to function as sand binders.

(ii) A reproducible fluidity test has been devised, based on allowing the mixture to escape through a two-inch hole in the bottom of a two-gallon tin. However, it has been established in the course of this work that the density of the mix is an all important factor being inversely proportional to fluidity and proportional to final strength. A minimum density of 1.3 gm/cc., controllable by anti-foam addition, is required for adequate strength. Curiously the densities of a mix in foamed and set states are identical.

(iii) Failure of some mixes to harden was encountered, and was traced to an off-specification batch of R.M.304, which was low in SiO_2 : Na_2O ratio and in total solids. When this was allowed for in formulation, normal hardening times were restored. There are indications that sodium silicate of 2.8 - 2.9 SiO_2 : Na_2O weight ratio give the best results. Silicate samples of various ratios intermediate between 2 : 1 and 3.3 : 1 have been received from Grosfields and are being assessed.

(d) Demonstrations were given on our premises for personnel from Jackmans and Fordath, and our first outside demonstration was given at G.K.N. Group Research Department, Wolverhampton. Both the demonstration and the subsequent casting were satisfactory, and we have been requested to produce a 6-ton ingot mould at their Dowlais works.

12. PROFAX IN STEEL FOUNDRIES

Development

Arrangements have been made to carry out trials with hand-rammed E.P.2311 sleeves (10" and 12" ID) at Jessop-Saville when compared with Feedex 50 and Feedex 725. In addition, it is hoped to be able to carry out trials with the centrifugally spun sleeves produced at Tamworth, in order to determine the comparable feeding efficiencies of exothermics and insulators.

the copper foundry. A test on steel has been attempted giving a good surface condition and good stripping, but unfortunately, we have had difficulties in shooting these sleeves on the Röper machine. Tests are at present in progress in order to reduce the grain size of the vermiculite which would be the cause of the trouble on the Röper machine.

Development - Foseco (F.S.) Limited.

Silica and Asbestos free Profax.

Tests have been carried out using grade (4) olivine sand from Norway, and to-date this material looks completely acceptable as a filler for Profax. A 25-ton consignment of this material is due in this country any time now and further work will be continued as soon as the material is at Tamworth.

Two samples of mineral wool have been evaluated as possible replacements for asbestos L.M. 319; mixes have been made using both samples in concentrations of 1, 2, and 3%. Green strengths increased with the higher percentages, but there was little difference in transverse strength. Only one sample has been tried on Amitec, which gave superior results to that from current Profax.

Four samples of chopped fibreglass have been received and have been successfully evaluated. However, these materials are very much more expensive than asbestos.

FEEDEX

Development - Foseco Inc.

Reformulation of most of the standard range of Feedex to deal with the current shortage of grindings is now almost complete. In the main, this has been accomplished without much disturbance of the quality of production, although some minor variations such as in the water requirement will be apparent in some cases. It is to be expected that some complaints will be received from the field, and that some further minor adjustments to the recipes will be required in the light of experience.

Work on American Steel Founders' Society.

Although our test results have not as yet been able to fully substantiate Foseco International's claim that English padding recipe No.3 gives consistently improved bend tests through lower aluminium silicon contamination, there are some indications that the hypotheses of

for spinning. A slurry containing 40% solids has been made at a 1 gall. mix and produces a sleeve with a wall thickness of 0.6" and negligible taper. Increasing the slurry addition to 1½ gallons (maximum capacity of this spinning chamber) gives a wall thickness of 0.7". Sleeves made from this recipe have been sent for field evaluation. Indications are that during the drying process of these sleeves, a reduction of 2-3% in the outside diameter of the sleeve occurs. The effect of reducing spinning time is also being studied and initial tests indicate that spinning times could be reduced to approximately 30 seconds, and possibly further without much significant increase in water content.

MOULD COATINGS

Terrapaint Development - Foseco Inc.

During the month of April, 107 batches of Terrapaint 55M were produced. No batches were found to be defective. Thus, it would appear that the change to pre-gelled bentonite combined with careful control of pH has completely eliminated the free liquid problem. The results of the shelf-life tests on these batches are not yet available, but preliminary indications are that the majority of the compaction troubles have also been eliminated.

Stelotol Development - Foseco Inc.

Stelotol 50.

A sample of a new gelling agent was received from the present supplier of aluminium octoate. This product did not gel as fast as X.1581, but when it finally did set, it formed a rather stronger gel. A larger quantity was ordered to make up a test batch for field trials.

Tests at Copperweld indicated that our present Stelotol 50 may give very poor deposits under certain conditions, i.e. tight moulds and poor air supply. D.P.2619/STL tested under similar conditions gave very good results. Because of the relatively poor performance of Stelotol 50 at Copperweld, present stocks were examined to see if they were up to par, or whether performance might have fallen off. Extensive tests revealed little, if any, detectable change. Final conclusions were that laboratory tests may bear little relation to field performance under some conditions.

Seventeen new raw materials were examined for suitability in improved Stelotols. Two of these, Hi-flash naptha (Ohio Solvents) and "Cyclosol 38" (Shell Oil) have been selected for further study of partial

Development of a Dressing similar to Thiem Satinkote - Foseco (F.S.) Ltd.

Although trials with D.R.869 have not been completed by Ford as yet with this material, which is being offered in competition to Satinkote, it has been renamed E.P.2718/TP for costing purposes.

Development of Improved Hot Box Coating for Ford Motor Company - Foseco (F.S Limited.

Verbal comments from the Ford Motor Company indicate that agglomerates of powdered material are still present which render the coating difficult to use. Ford also express a desire that the viscosity curve of the dressing should be flattened within the 15-16 second range. The coverin power of this coating was found to be from 23-24 (a Ford Motor Company standard) and is satisfactory for their use. Work is continuing with this project.

Comparison and Evaluation of South African Coke Blacking and Morgan Blacking Foseco (F.S.) Limite

23 drums containing two types of blacking have been sent in by G. & W.Base Minerals Limited. There were two types available in these 23 drums, the only difference being the grades of coke used.

All results so far tie in well with those obtained on the previous small samples, apart from the self-severe applied coating.

A similar series of tests have been carried out with a blacking obtained from the Morgan Crucible Company Limited again to compare its properties with Durrans 10. Findings to-date are that this Morgan material is coarser than the South African, but slightly finer than Durrans. It has the following mesh grading:-

9% +200
11% +300
Balance -300

Coating tests revealed that the material had a similar hardness characteristic to Durrans 10. Test castings have been prepared and are at present being shot blasted prior to examination.

Development of a Coating to compete with Durrans Steelmol 15 - Foseco (F.S. Limited.

This product has had satisfactory field tests, but British Roll Makers Limited have at the same time carried out gas evolution tests on thi dressing and compared their results with Durrans 15. Discrepancies between results obtained by ourselves and British Roll Makers are believed to be du to differences in procedure. Our apparatus is, therefore, being modified t overcome these discrepancies and further tests are being carried out.

3. At reduced levels sodium silicate binder, i.e. 2%, Process 34 allows manufacture and use of cores which are otherwise impracticable, therefore, knock-out properties are excellent with both copper and cast iron.

4. At these reduced levels of silicate binder, satisfactory cores cannot be made with Dexil 11.

5. Process 34 enables a saving to be made in the cost of silicate binder because of the small amounts used.

Generally, Process 34 is and may be classed as rather a sodium silicate binder extender, rather than a breakdown agent.

Mixad Development - Foseco (F.S.) Limited.

Mixad 61 is now being used on a regular basis. It has taken approximately six weeks to show that the addition rate of Mixad 61 for this particular plant, purely as a replacement, is between 4½-6 cwts. per day. A detailed scrap analysis over the months of March and April indicates that some saving may be expected following the considerable reduction in expansion defects. An improvement has also been observed in the casting finish.

Corfix Development - Foseco Inc.

In view of the excellent results and sales in Mexico of Corfix 4, it was decided to try this product. Tests were run with Corfix 4, Corfix 40, and a powdered version of Corfix 4. Respective tensile strengths were 225, 110 and 165 p.s.i. In view of the relatively low raw material cost and the results obtained, it was suggested that this product be evaluated in the field.

FLUXES

Zinc Coveral Development - Foseco Inc.

Improved Zinc Coveral for General Use.

Since General Motors, Trenton, New Jersey, have already tried Zinc Coveral 87 in the past, it was decided to try the new English high temperature recipe. Experiments in the foundry indicated that R.D.881 (D.P.2621) flux would work well, without giving noticeable fumes at a temperature of 950°F. A sample was submitted for trials early next month.

FOSECO - FORDATH

The FPR/17 resin is meeting with considerable success in many of the larger foundries in the country. An improved catalyst system containing a much lower nitrogen content has been developed for use with FPR/17. This will reduce the possibility of pin-holing even further.

The cold-set equivalent to FPR/17, which is to be named CS. 60, has now been successfully completed, and field trials are at present being conducted. Early indications are very promising, and it is hoped to release this product for general sales in the immediate future. It should be noted that this is not completely furfuryl alcohol free, but contains a substantially lower percentage than other cold-setting resins.

A sample of HB31 manufactured by Adryzyl, Brasil, has recently been received, and is being evaluated by the Fordath Engineering Company.

TECHNICAL SERVICE

Miscellaneous Short-Term Development.

(a) Pickling Inhibitors.

The size/Teepol inhibitor manufactured by G.F.Powell(E.P.2681) was only slightly effective at the recommended concentration of 0.1%; it permitted considerable metal loss together with heavy staining. At 1.0%, inhibition was improved to 81%, but staining persisted. A further very slight improvement resulted from increasing the size/Teepol ratio. The competitive Armohib 25, at 0.04%, gave 96% protection and a bright finish.

Dowfax 2AI, a commercial detergent, had some inhibiting properties and formed a stable foam on the surface of the bath, thereby suppressing acid spray. At 1% it gave an inhibition of 79%, with metal staining. A mixture of 1% Dowfax 2AI and 0.01% phenylthiourea gave 90% protection and a bright finish.

All the inhibition figures are for 20% H_2SO_4 at 90°C.

(b) Development of Inoculin for High Strength Irons.

Further experimental foundry trials give continued confidence in R.M's X1483 and 1150. in respect of both chill reduction and tensile

(g) Moldcote 33.

The claim of Foseco, Australia, that the use of R.M.408 instead of R.M.129 in bentone gel improves storage/transportation (suspension) properties of Moldcote 33 has been upheld in laboratory tests. Foseco (F.S.) Limited, Foseco Espanola S.A. and Foseco G.m.b.H., who have all expressed recent interest in this field recently will, it is hoped, comment shortly on their findings.

(h) Mixad 61.

1. A sample of material for potential use as R.M.269 in Mixad 61 has been examined for Foseco, Italy. It was found to be of some value but not up to the standard of U.K. R.M.269.

2. Five samples of potential R.M.269 were examined for Foseco Inc. Only one appeared of any great value and this was not completely up to standard.

3. R.M.269Z from Foseco, France, has been examined with satisfactory results.

4. Tests are in progress to reproduce a metal/mould reaction with L.M.4 aluminium alloy which has been reported in the field where Mixad 61 is used in the moulding sand. There are some small signs of success and the phenomena will be studied in conjunction with Foseco (F.S.) Limited.

(i) Inoculin 10.

Two samples of Inoculin 10 from Foseco, Germany, which contained slightly coarser than recommended graphite, have been examined. Because the graphite was of very good quality, the oversize grading was considered tolerable when normal supplies were not available.

Two samples of R.M.427B have been examined for use in Inoculin 10 Both are already in use. One material from Foseco, France, was felt to be not quite up to the standard of U.K. R.M.427B, the other from Foseco, Argentina, was only lacking in respect of size grading.

(j) Konserver.

This is a competitive product for addition in the cold-set furane resin sand process. Its chief attribute is in water proofing cores but in view of the fact that the ½% addition replaces some of the resin, it has economic value also. It is being examined together with other materials which might do the same job. Results are not yet available.

(k) Profax - Fabrex.

Foseco, Japan, have experienced serious stripping problems with

amounts of sodium nitrate and sodium sulphate were present, this is not surprising. The main exothermic reactions are the uncontrolled, direct reactions between aluminium and the alkali nitrate and sulphate.

Exomold MLD-R, the latest light-weight resin bonded exothermic material from the Exomet Corporation, contained the usual ingredients favoured by this manufacturer; I.R. spectron analysis indicated that the resin was a partially solubilised phenolic novolac without an addition of hexamine.

Other materials analysed this month were as follows:

1. A flux for aluminium alloys from Italy which is stated to dross off satisfactorily as low as 620°C.

2. Four Japanese mould dressings which are in competition with Terracote 46.

3. Coremol, a water-based zircon paste from America. This was competing with Terrapaint 55.

4. An Archer-Daniels-Midland mudding compound from Foseco Inc.

5. An insulating sleeve prepared from perlite and calcined alumina and also submitted by Foseco Inc.

6. A combined wetting agent and pickling inhibitor obtained in Italy by Mr. D.W.Leonard.

MISCELLANEOUS

Metallurgical Laboratory.

Number of Customer Service items received	14
Number of Customer Service items completed	12
Number of Metallurgical Reports issued	6
Number of Analytical Reports issued	1
Number of Outstanding items	6
Date of oldest outstanding item	13.3.65
Number of Internal Service items received	41
Number of Internal Service items completed	47
Number of Internal Service items oustanding	10
Date of oldest oustanding item	10.3.65

been blended in this blender, and recommendation has been made to revise batch weights. In some instances, this reduction in weight amounts to 50% of the quantity previously mixed. The possibility of this problem arising again has been eliminated by insisting that no batch weights are assigned to new formulations without an initial determination of the powder density on an experimental basis.

NO REPORTS WERE ISSUED DURING THE PERIOD - 1ST APRIL - 30TH APRIL, 1965.

WOA/DMH
14th June, 1965.

W.O.ALEXANDER.

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