



Material Screening Procedure

IEX Technologies Ltd (IEXT) is focused on developing advanced technologies to remove valuable or problematic contaminants from solutions, particularly in industrial process streams and effluents. IEXT materials are comprised of a chemical functional group attached to an inert backbone material such as silica or a polymer. The chemical functional group is used to remove Platinum Group Metals (PGMs) from liquid streams. Typically, PGM containing feed solutions are contacted with IEXT media in either stirred batch reactors or continuous flow fixed bed type processes. Once PGM uptake is completed, the IEXT media can be sent for refining or potentially regenerated on-site for re-use.

A crucial part of IEXT process development is conducted at laboratory scale where material performance in the customer feed solution is evaluated. This document details a recommended screening procedure that can be followed to test the performance of the IEXT materials in a specific application.

IEXT Product types

Included in this package are material samples from the two major product families offered by IEXT:

- Silica based materials:
 - Functional Silicas (FS) (TP-1200): Irregular large particle silica-based products. Pore volumes, particle sizes tunable. Preferably for flow systems. Generally one-off materials.
- Polymer / Resin based materials:
 - Functional Polymers (FP) (IEX-TU): Macroporous uniform organic resin beads. Available as Pharma and technical grades. One off and re-generable resins available. Excellent in flow systems

Overview of IEXT Process Development

Development of IEXT process at laboratory scale involves four distinct steps. The first three steps are conducted as batch trials while the final fixed bed test requires continuous flow of feed solution and thus a pump and column equipment. Depending on the customer requirements, not all of these steps need necessarily be carried out.

Initial Screening trials

The initial screen is used as a feasibility study to determine the most suitable IEXT materials for PGM recovery of a target species. The presence of competing species in solution should also be identified at this stage.

Isotherm trials

The purpose of these experiments is to determine the dynamic equilibrium relationship between the species in solution versus adsorbed on the material in addition to the maximum capacity of the material.

Kinetics trials

The purpose of these experiments is to gain information on the rate of adsorption of species from solution onto the adsorbent material.

Column trials

This experiment is designed to test PGM uptake in a fixed bed process. Data collected in previous steps is often used in planning these trials. The results are then used in scale up and process design to a pilot or full-scale process.

As part of this sample pack, the Initial Screening Trials are described in the following sections.

Initial screening

The initial screen functions as a feasibility study to identify effective IEXT materials for PGM recovery from solution. The trials are most conveniently carried out in batch-wise operation, *i.e.* IEXT material is added to liquid in suitable vessel and allowed to contact for a set time. It is preferable to agitate/mix the IEXT media in solution to maximise contact and give a relevant PGM uptake result. For mixing there are several ways to accomplish this, the most common of which are listed in the table below. If there is no suitable mechanical equipment available at the customer site, then alternatively the solution can be frequently mixed by hand and/or the contact time extended.

	Comments	Suitability	
		FS	FP
Hotplate with magnetic stirrer.	Single or parallel trials possible. Can be heated but requires separate reflux condensers.	Not optimal. Care with mixing required.	Not optimal. Care with mixing required.
Rocker-roller mixing apparatus.	Parallel trials are possible. Inexpensive equipment. Room temperature reactions.	ok	ok
Radleys Carousel.	15 trials in parallel possible with built in reflux condensers and easy option to use also protective gases.	Not optimal. Materials in bag can be used.	Not optimal. Materials in bag can be used.
Flask with overhead stirrer.	Typically single trial only. Laborious set-up.	ok	ok
Vessel without stirring.	Most laborious, required manual shaking of liquid/solid mixture.	ok	ok

Preparation of the feed solution

Prior to IEXT material screening filter 200ml of the solution using Whatman 541 filter paper or equivalent to remove any solids, fine particulate or contaminants.

The pH of the sample should be recorded along with a brief description with particular reference (if relevant) to colour, viscosity and solvent.

Equipment Required

The following laboratory equipment will be required to complete the screening trial:

1. Test tube or beaker or suitable container for each material to be tested.
2. Hotplate with magnetic stirrer or rocker roller mixer.
3. Balance.
4. Whatman 514 or equivalent filter paper (25µm) and apparatus.
5. Sample bottles.
6. Assorted glassware.

Amount of Scavenger

The standard amount of IEXT media used in the initial screening is 1 w/v% (= 10 g per L of solution). This amount is usually sufficient for PGM concentrations up to 500 ppm (total). However, if a single element or the total PGM concentration has a higher concentration than this, more IEXT media will be required. For samples with a PGM content in the region of 500 – 1000 ppm PGMs, 3 w/v% IEXT is recommended for initial screening.

Note: that this is 1 w/v% on a dry material basis. Thus if the material has a 50% moisture content, 2 w/v% of the as received material should be used in order to have 1 w/v% of the actual material itself.

Temperature

The standard temperature at which initial screening occurs for aqueous samples is ambient. However, elevated temperature can be used even in these feasibility trials if the process conditions (in plant) are at elevated temperature. Heating of samples usually improves kinetics of PGM uptake. Recommended upper temperature limit is 70°C for FP and 100°C for FS. For organic samples, the maximum temperature adopted should be around 10°C lower than the boiling point of the solvent.

Time

The standard contact time in initial trials is 2 hours.

Screening Procedure

1. Take a sample of the feed solution and retain for species concentration analysis. This is the 'Untreated feed sample'.
2. Use one clean and dry test tube or beaker for each IEXT material type to be screened.
3. To the tubes add 15ml of feed solution.
4. Weigh out the required amount of each IEXT material to be screened.
5. Add the first weighed IEXT material type to the first test tube, the second type to the second tube and so on. Record the masses added.
6. Start the mixing and (if required) heating of the tubes.
7. After two hours, turn off the mixing and heating. Allow the samples to cool before handling.
8. Separate IEXT materials from the tube solutions by filtration. The remaining solutions in the tubes are the 'Treated feed samples'.
9. Note any significant colour changes of the solutions. Analyse the concentrations of all relevant species in the untreated & treated solutions using an appropriate analytical method.

Recording results

The results from the trials are most conveniently reported in table. An example of which is shown below.

Material	Vol liquid (ml)	% moisture content of material	Weighed mass of wet material (mg)	Concentration, species A (mg/l)	Concentration, species B (mg/l)	Concentration, species C (mg/l)
Initial (Untreated feed sample).	-	-	-			
IEXT#1 (Treated feed sample).						
IEXT#2 (Treated feed sample).						

Once you have completed your Initial Screening trials, or if you have any difficulty in performing the trials, do not hesitate to get in contact with IEXT: info@iexconsultants.org. A full screening procedure covering Isotherm, Kinetic and Column trials is available if it is of use.