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TECHNO-ECONOMIC PROFILE ON WATER FILTERS AND REPLACEMENT ELEMENTS

(PROJECT NO UC/RAB/903011
CONTRACT NO 90/023P)

35 p
tables
diagrams
illus.

TECHNO-ECONOMIC INVESTMENT PROFILE

ON

WATER FILTERS AND REPLACEMENT ELEMENTS

(PROJECT NO UC/RAB/90/011 - CONTRACT NO 90/023P)

July 1990

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TECHNO-ECONOMIC PROFILE

ON

WATER FILTERS AND REPLACEMENT ELEMENTS

(PROJECT NO UC/RAB/90/011 - CONTRACT NO 90/023P)

1.0 EXECUTIVE SUMMARY

Water filters for the domestic and light commercial market are widely used to improve the potability of mains water supplies. The filters are of simple design, manufactured from plastic moulded components and are easily installed directly into existing piped water supplies. The filter elements are textile bobbin, sintered polyethylene, or ceramic, and in some cases incorporate odour removing activated carbon. The plan is to manufacture the textile bobbin type completely, part manufacture the sintered polyethylene type, and import the ceramic type in bulk for local packing.

An annual production rate of 50,000 water filter units plus an extra 500,000 replacement filter elements is planned for the end of the third year. This represents an anuual turnover (excluding royalties) of US$ 4,968,000. A high level of promotional expenditure is expected to enable these sales to be achieved. The projected gross profit at the end of this first year is US$ 1,132,000 after promotional costs of US$ 1,440,000. The investment in machines is estimated at US$639,000 to which must be added erection, training, travelling and license fees of US$310,000 giving a total of US$949,000.

These complete filters and replacement elements are all domestic types. At a later stage the programme may develop into the professional high pressure types, but that is not part of this project study. 'High pressure' and 'low pressure' in this report refer only to domestic water pressures.

2.0 PRODUCT DEFINITION

Water filters are widely used to improve the potability of the mains water supply to domestic and small commercial properties. The total current market for this product in the Arab Gulf region is estimated at 1.4 million units.

The design of filter is very simple (see Fig 1 & Fig 2) comprising a renewable filter element, filter bowl, sealing ring and main housing which locates the filter element in the bowl and provides threaded input and output connections to installed piping.

Filters must be available at a price acceptable to a wide cross section of many communities. Such low cost filters can be added directly to existing piping without incurring high installation costs or alternatively can be fitted to free standing water containers.

It is common to use one size and design of filter unit for all applications. Typical overall dimensions would be 310 mm height by 110 mm diameter. Most applications require a pressure rating of a maximum of 5 bar and there is a lesser demand for pressure rating of 8 bar. The latter product would typically be identical to the lower rated product but use thicker components.

There are four types of functional renewable filter element:-

TYPE		MARKET SHARE
a)	bobbin wound textile	35%
b)	sintered polyethylene	35%
c)	porous ceramic	20%
d)	textile with activated carbon	10%

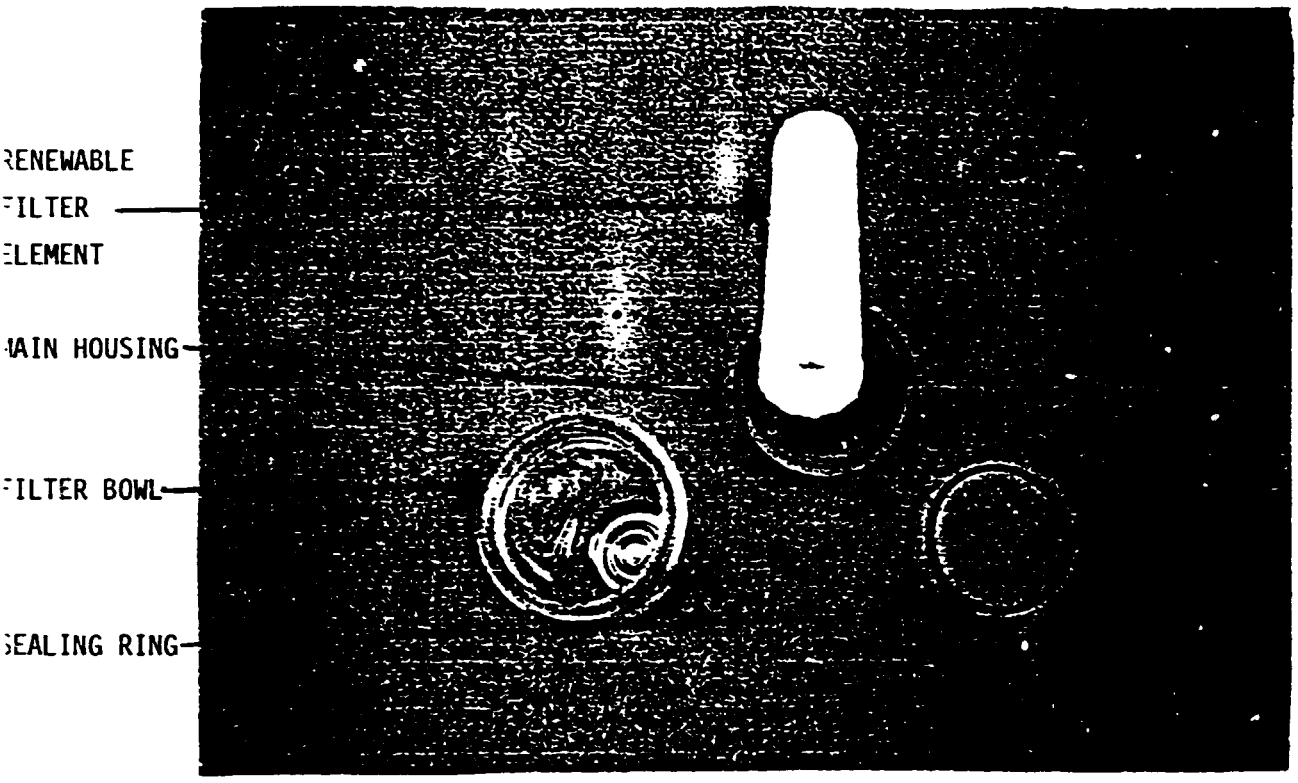


FIG. 1 (a) Main Components of water filter unit

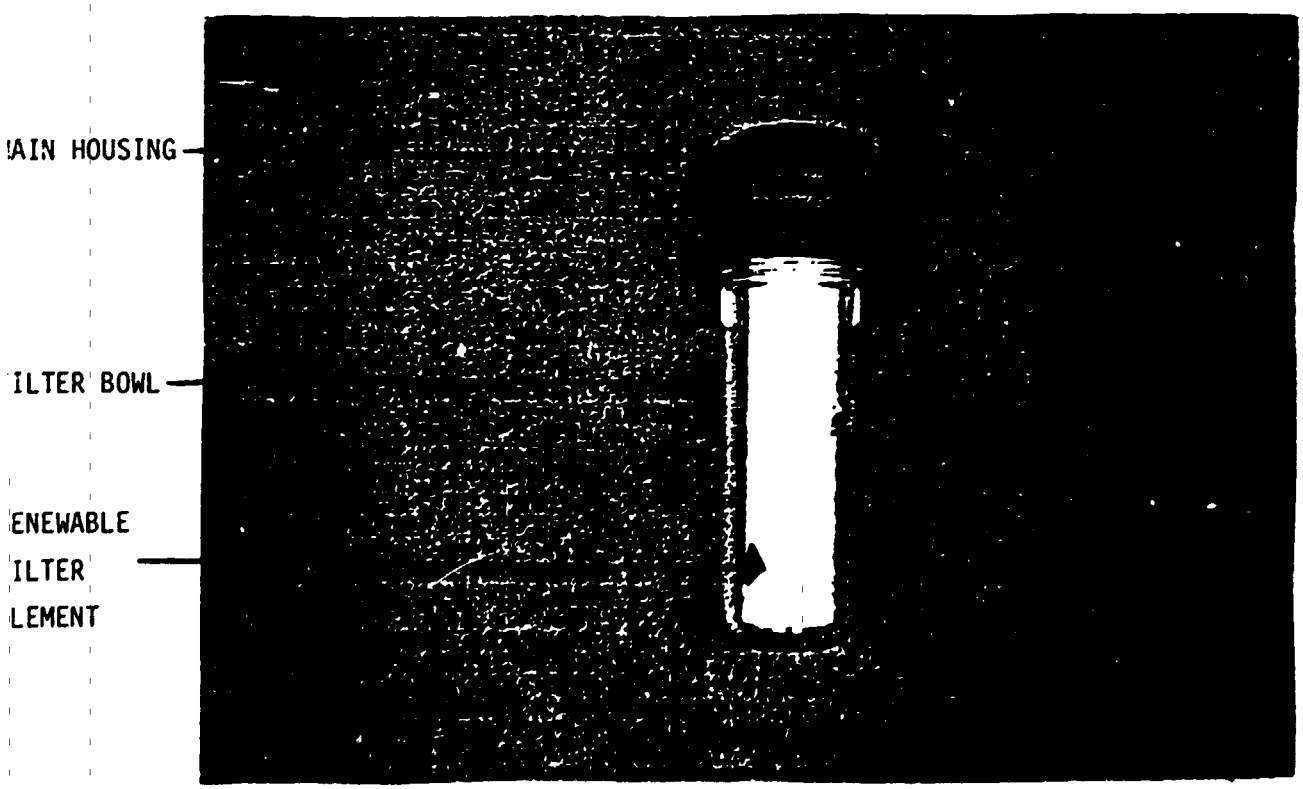


FIG. 1 (b) Complete Water Filter Assembly

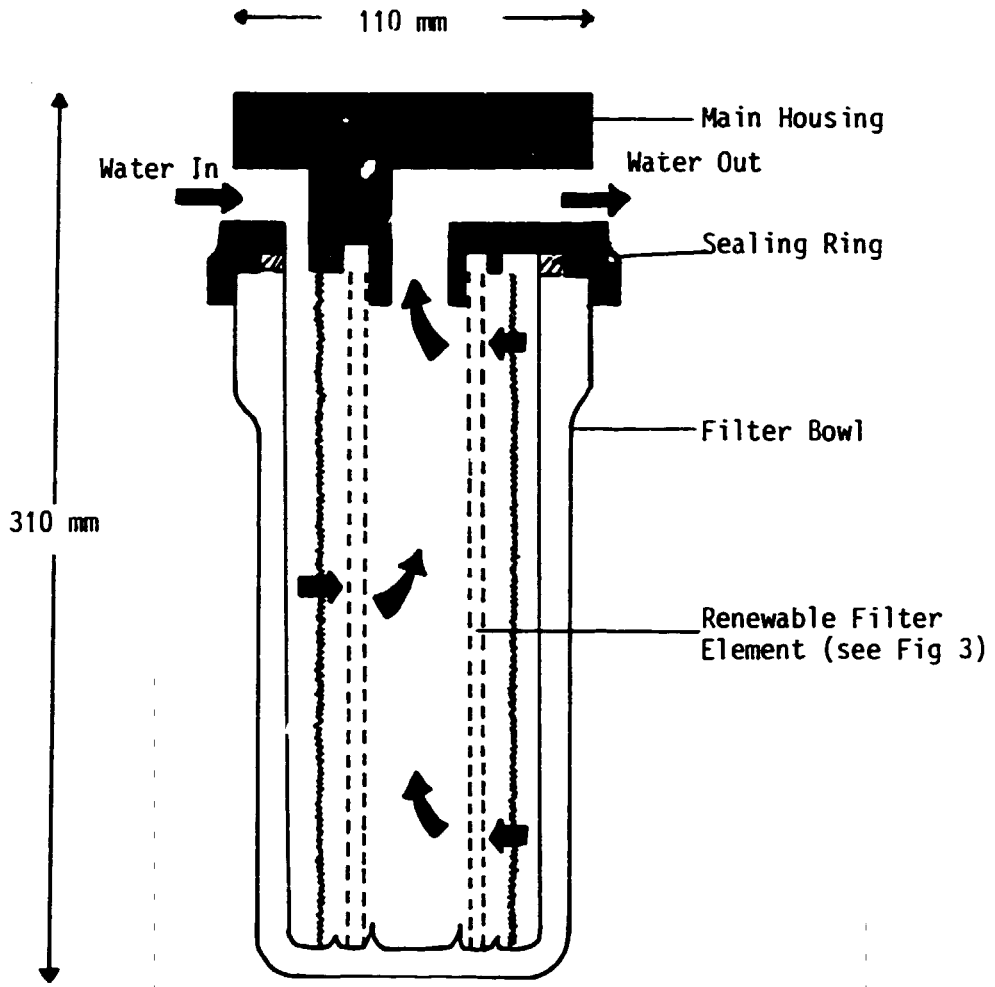


FIG 2 - CROSS-SECTION THROUGH WATER FILTER UNIT

It is recommended that performance of the filtration levels should be substantiated by tests to British Standards BS6068 Water Quality (or other international equivalent standard), especially:-

BS6068 Section 2.14 - Determination of Turbidity
BS6068 Section 2.22 - Determination of Colour

Materials of construction would be expected to conform to DD82:1982, (DD = British Standard Draft for Development):-

"Specifications of requirements for suitability of materials for use in contact with water for human consumption with regard to their effect on the quality of the water."

The typical performance data for such water filters is:

Maximum water volume flow - 0.10 ltr/s for 5 bar max pressure application
Maximum water volume flow - 0.25 ltr/s for 8 bar max pressure application

Filter Life	6 months
Total filter capacity	2500 ltr

Pressure drops with sintered polyethlene and with ceramic cartridges are higher. Flows will typically be less than half the above for similar supply pressures. Filter life will also be shorter for a given contamination level.

Experience of the wide variation in contamination levels and spectra that may be found suggests that claims on filter life (and times between cleanings of ceramic types) should be made in general terms only. A sharp but temporary increase in contaminent levels may not make much difference to the average contaminent level of water supply, but would dramatically shorten filter life.

3.0 TECHNOLOGY REVIEW

3.1 Production Options

The main components can be manufactured from a variety of materials including:-

- Cast iron
- Metal pressing
- Hand laid-up or semi-automatic production of glass - reinforced plastics
- Injection moulding

Materials must be corrosion resistant and not affect the potability of the water. However, it is important that the appearance should conform to perceptions of an appropriate domestic installation. Injected moulded plastics are an ideal material.

Filter element production options include:-

- A textile filter (see Fig 3).
- A combined activated carbon/textile filter (see Fig 4) or plain activated carbon filter.
- A porous ceramic filter.
- Sintered high density polyethylene

The textile type of filter consists of a perforated plastic tube onto which is wound a textile yarn.

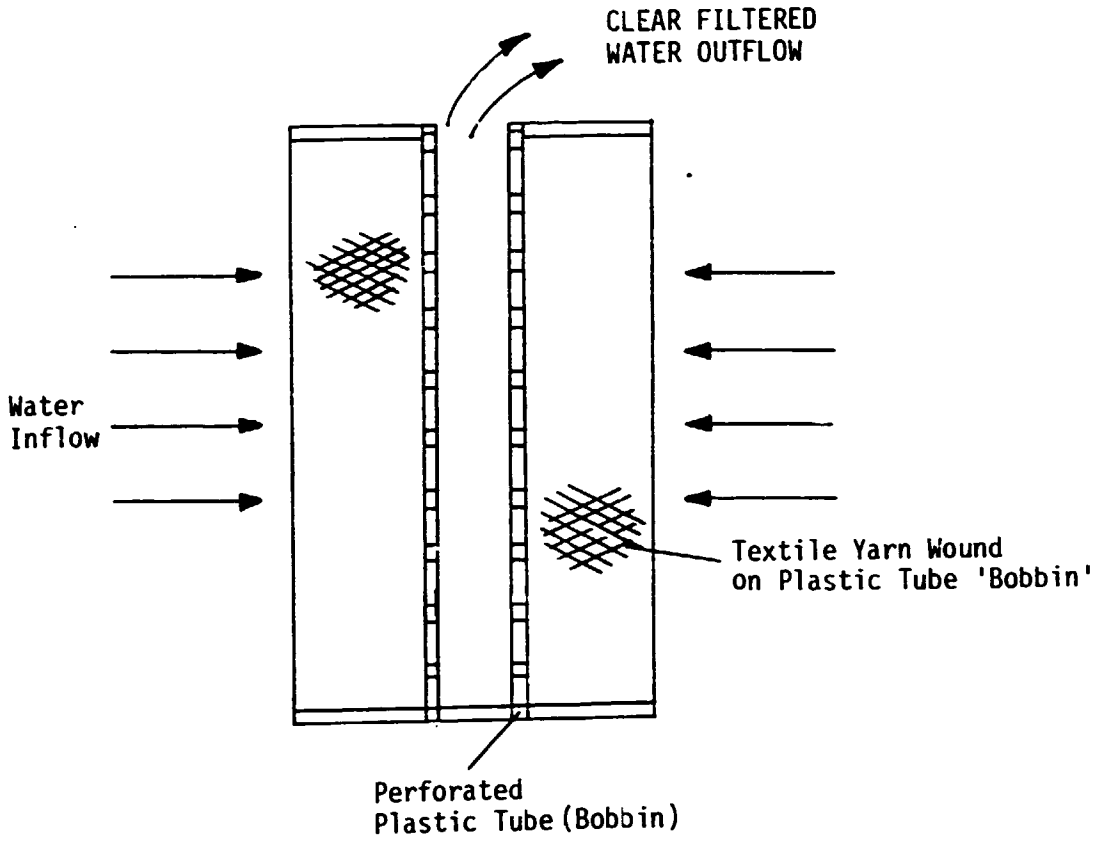


FIG 3 - CROSS-SECTION OF TEXTILE FILTER ELEMENT

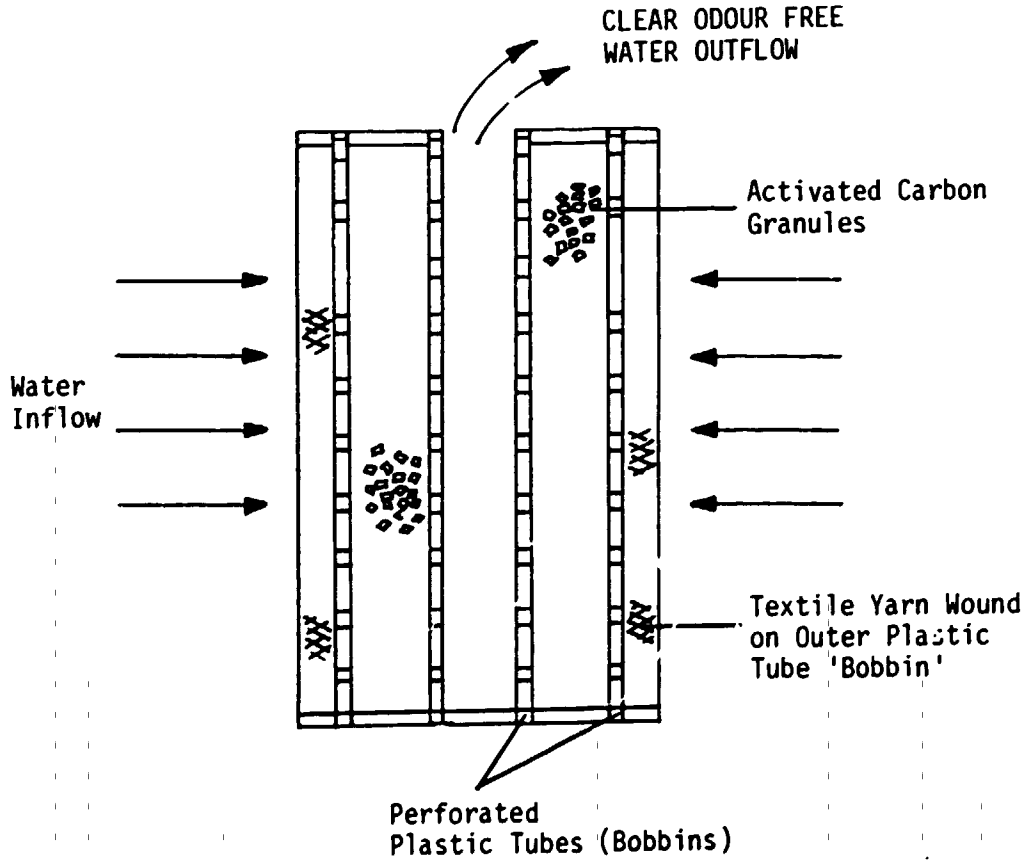


FIG 4 - CROSS-SECTION OF COMBINED ACTIVATED CARBON/TEXTILE FILTER

All odour removal filters use activated carbon as the odour removal medium. The carbon granules will also act as a coarse sand filter and remove sediment. However, to prolong the life of the expensive carbon granules it is preferable to have a sediment removal filter in front of the carbon granules. A recommended production option is a textile filter which contains carbon granules (see Fig 4). The textile filter removes the sediment enabling the carbon granules to remove the odour for a longer period.

While porous ceramic water filters are efficient at removing sediment, they cannot achieve satisfactory water flow rates at typical domestic water pressures.

Porous ceramic filters are offered on the basis of importing in bulk and packing locally.

Sintered porous polyethylene offers a functional solution part way between textile and ceramic. The medium is to be imported in bulk for local cutting, shaping and assembling in a locally manufactured plastic support cylinder.

3.2 Review of Production Scale Ranges and Governing Factors

For volume production, injection moulding is the preferred technology. There are basically 3 mouldings:-

- Main housing
- Filter bowl
- Perforated plastic tube (bobbin)

Unless the moulding activity is sub-contracted, the minimum production capacity will equate to the output of one moulding machine. Using single

item tooling, this would give a production capacity of about 30 complete filters per hour. Allowing for cleaning and set-up time, this is equivalent to 1000 filters per week on single shift working.

Production could be increased in units of 1000 per week by adding additional injection moulding machines. Proportional increases could be obtained by increasing to 1.5 or 2 shift working, ie, up to 2000 filters per week.

Whilst the initial production of new filter elements will be to support the production of filter bodies, the aim is to increase rapidly to a 10:1 ratio of filter elements to complete filters.

3.3 Recommended Production Technology

The recommended production stages are therefore:-

a) Plastic injection moulding to form the following finished shapes:-
   - main housing
   - filter bowl
   - filter element bobbin
   - activated carbon cylinder

b) Textile yarn winding of filter bobbins.

c) Granule handling comprising a hopper feed and shaker for filling the moulded cylinders with activated carbon granules.

d) Cut, form and stick the sintered polyethylene filter media.

With regard to plastic materials to be used, the main housing, filter bobbin and granule container could be made from a number of materials including Polypropylene, ABS, and Polyamides.

It is better to use a clear transparent material for the filter bowl to enable the state of the filter to be assessed visually. Suitable materials are acrylics or polycarbonates. Raw material suppliers should be able to advise which plastics in their range conform with DD82.

3.3 Suppliers of Technology

The simplest way to secure the technology would be to reach a licence know-how agreement with an existing water filter manufacturer.

Companies having expertise in water filtration and water treatment include:-

MICRO-MESH ENGINEERING LIMITED
51 Basford Road, Old Basford, Nottingham NG6 0GA, UK
Tel : 0602 786348

PORTACEL LIMITED
10 Tannery Road, Tonbridge, Kent TN9 1PR, UK
Tel : 0732 364411 Fax : 0732 362575 Tlx : 95467

WATER FILTERS SRL
3/5 v. I Magio, 42018 S. Martino, italy
Tel : 522 69 50 65 Fax : 522 69 86 79 Tlx : 532135

APIC
BP 92 92405, Courbevoie Cedex, France
Tel : 43 34 03 30 Telex : 613937

AQUA QUICK WASSERTECHNIK
29 Jungwaldstr, 6635 Schwalback 4, Germany
Tel : 6834 548 62

ESMIL BV
7 De Boelelaan, 1083HJ Amsterdam, Netherlands
Tel : 20 541 10 54 Tlx : 10295

Alternatively, as the major part of the technology is in injection moulding, one could separate out the different aspects of the technology:-

- Water filtration technology
- Injection moulding technology
- Textile yarn winding technology

Companies having special expertise in plastic injection moulding include:-

SS PLASTICS MACHINERY SYSTEMS LIMITED
BOS House, Weston Square, Barry, South Glamorgan CF6 7YF, UK
Tel : 0446 741 133 Fax : 0446 746 120 Tlx : 497223

OIMA SPA
172 v. Feltrina Sud, 31044 Montebelluna, Italy
Tel : 423 205 41 Fax : 423 240 35 Tlx : 420063

BATTENFELD FISCHER BLASFORMTECHNIK GMBH
7 Hermann Lons Str, 5204 Lohmar 1, Germany
Tel : 2246 140 Tlx : 889426

Companies with textile winding expertise include:-

ALL-TEX NV
8 bld des Fusilles, PO Box 35, 9600 Renaix, Belgium

Tel : 55212268

TEXTILWERKE AHAUS AG
10 Parallesistr, 4422 Ahaus, Germany
Tel : 2561 20 51

BENTLEY ENGINEERING COMPANY
New Bridge Street, Leicester, LE2 7JS, UK
Tel : 533 54 10 10

A company with expertise in the manufacture of ceramic filters with and without activated carbon in the ceramic mix is:-

FAIRLEY INDUSTRIAL CERAMICS Limited
Silley Brooks, Stone, Staffordshire ST15 0PU
England

A company with expertise in the manufacture of sintered high density polyethylene is:-

PORVAIR plc
Filtration Division, Estuary Road, King's Lynn
Norfolk PE30 2HS, England

4.0 THE PRODUCTION PROCESS

4.1 Description and Flow Sheet for Recommended Technology

The production process for assembled water filter units and replacement filters is summarised below (and in Figure 5). The suggested equipment layout is shown in Appendix 1. The operations are based upon the batch production of components from two injection moulding machines, see Appendix 2. The operations rely upon manual transfer of part finished components and upon manual assembly of the finished product.

1. Preparation of Plastic Raw Material

   Receipt and storage of new plastic granules. Plastic moulding flash and scrap must be recovered and re-ground into pellets for mixing with new material (typical ratio is 10% reground to 90% new material).

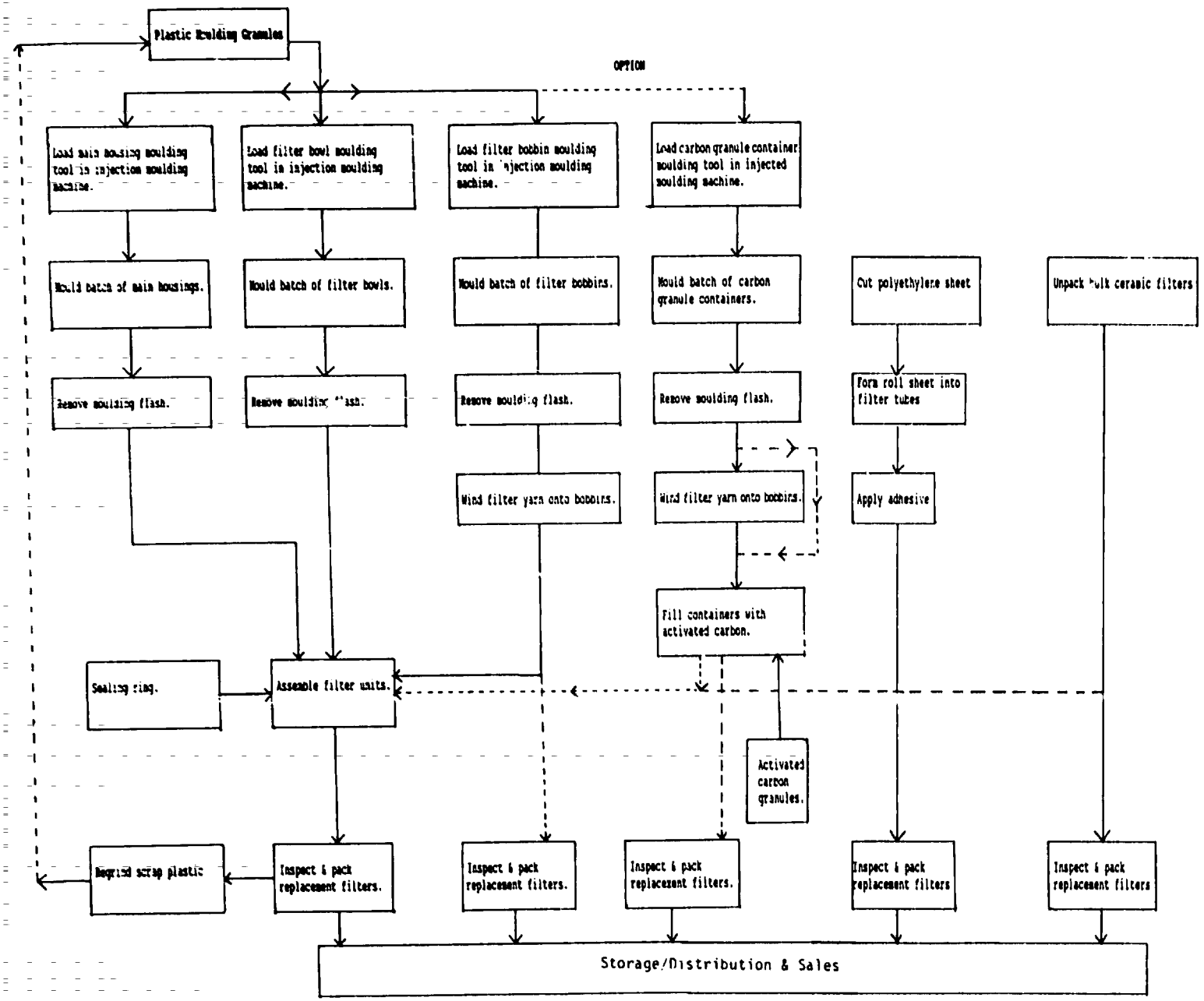
2. Preparation of Moulds

   Long moulding runs prolong the mould tool life. Moulding tools must be cleaned and inspected each time they are removed from the moulding machine. Moulding tools require refurbishment typically once per year.

3. Moulding

   Warming up the moulding machine can take about one hour at the start of a shift, and initially only scrap will be produced. It is preferable therefore to run the moulding machine for periods longer than one shift. The scrap made during machine run-up is reground for re-use. The secret of good moulding is the quality and maintenance of the tools. Once the injection moulding machine has warmed up and is running smoothly, a relatively inexperienced operator can produce high quality mouldings.

FIG 5 - PRODUCTION FLOW CHART FOR WATER FILTERS



4. Flash Removal

Overspill of plastic from the mould is termed flash and is removed from the newly made mouldings. As tooling wears, or dirt enters the tooling during a shift, so the amount of flash will increase. Flash is easily removed by hand or with hand tools.

5. Filter Winding

This is a semi-automatic process. The machine operator basically feeds the bobbin and watches for yarn faults. This process can be fully automated if production volumes are sufficiently high.

6. Water Filter Assembly

This requires the finished filter to be inserted into the filter bowl. A sealing ring is then added to the housing, and the bowl screwed to the main housing. The complete units are packed into individual boxes which are subsequently packed into a carton ready for despatch. This is a manual process which could easily be automated when volumes reach an appropriate economic level.

7. Sintered Polyethylene Filter Elements

Sheet material is cut to size, passed through rollers, wrapped around a mandrel and one butt joint made. The element is then inserted into a support cylinder, packed into its box and carton packed ready for despatch.

8. Testing

Sample testing of units on the hydraulic test bench is required to ensure that progressive changes in mouldings do not result in leaks under appropriate water supply pressures.

4.2 Outline List and Cost of Machinery and Equipment

Quantity	Item	US$ each	US$ total
2	Injection moulding machine	125.000	250,000
1	Plastic regrinder	012,000	012,000
1	Main housing mould	034,000	034,000
1	Filter bowl mould	034,000	034,000
1	Bobbin mould	026,000	026,000
1	Odour granule container mould	030,000	030,000
2	Bobbin winder	030,000	060,000
1	Hopper and shaker table (for filling granule containers)	017,000	017,000
3	Assembly and packing tables	002,000	006,000
3	Pallet truck	001,000	003,000
1	Assorted hand tools	010,000	010,000
1	Hydraulic test bench	010,000	010,000
1	Air compressor and lines	021,000	021,000
6	Racks	001,500	009,000
1	Guillotine	002,000	020,000
2	Power rolls	001,000	020,000
50	Mandrel	000,100	005,000
2	Adhesive application units	002,500	005,000
1	Polyethylene support cylinder		
5	mould	030,000	030,000
1	Forklift and pallet truck	040,000	040,000

4.3 Budget Cost Estimate For Machinery (Origin: Europe)

Machines	US$ 639,000
Carriage	US$ 033,000

4.4 Budget Costs for Erection of Machinery

This assumes two specialists are sent out from Europe, and that an adequate supply of local labour and tradesmen are available. The cost of local accommodation of specialists is not included.

Specialist Installers	US$ 48,000
Flights costs	US$ 12,000

Commissioning of the machines and helping to run up the plant should form part of any know-how, purchase or license agreement.

4.5 Site Requirement

A level site with mains electricity, water and sewage connections is required, with reasonable access for heavy road transport. The site should be not less than 1.5 times the floor area of production facilities which are a minimum 800 square metres for the building.

Ideally, a site 2.5 times the floor area (50m x 40m) would allow for future expansion.

The site layout is shown in Appendix 1 and comprises:-

- Main Building (800m^2) close to access road;
- Office section facing road;
- Access and marshalling area along the side length of the building;
- Spare land for storage at the back.

4.6 Buildings and Civil Works

The main building should be weather proof and appropriate to local climatic conditions. There will be no abnormal floor loads. Surface drainage should be adequate to prevent flooding of the factory area.

The front office section of the building should contain:-

- General Manager's office
- Production Control office
- Sales and Administration office

The total office space is likely to be 19% of the total building, ie, 150 square metres and should be provided with:-

- 3 phase electrical supply (150 kVA)
- Water (general washing and cleaning only)
- Sewage (no special effluents)

4.7 Raw Materials

Some raw materials will be available in the Gulf area, and so a number of material options are listed to enable local sourcing to be used if preferred. The difference in cost between local and import may be quite small and is unlikely to affect any project decision.

a)	Plastic granules (drums)	Polypropylene, ABS, or Polyamide
b)	Clear plastic granules (drums)	Acrylic, Toughened Acrylic or Polycarbonate

c)	Twisted yarn (large reels)	Polyester. Acrylic
d)	Sealing rings (boxes)	Rubber, Nitrile, or Silicone
e)	Packing materials	Boxes and Cartons
f)	Release agents	For use in injection moulding machines

The production rate assumed for the third year is 3000 units per week. Total weight of raw materials for this production level is 216,000 kg per annum or 4,500 Kg per week. The opaque plastic comprises about 40% of the weight, the clear plastic 50%, the textile yarns 5% and packing 5%.

Anticipated gross scrap and rejection rate is 5% of which 4.5% can be salvaged easily as regrind plastic. The net scrap rate is therefore only 0.5%.

4.8 Raw Material and Consumable Items Prices

Typical input costs per water filter are:-

	High Pressure Unit (US$)	**Low Pressure Unit (US$)**
Opaque plastic	1.20	1.20
Clear plastic	2.55	1.80
Textile yarn	0.17	0.12
Packing	0.34	0.34
Consumables + scrap	0.07	0.07
Total	**4.33**	**3.53**

For the odour treating filter, typical extra costs per unit will be:-

Opaque plastic	US$ 0.17
Activated carbon granules	US$ 0.50

Typical input costs per replacement filter element are:-

ITEM	US$
Ceramic filter (plain)	08.53
Packing	00.30
Total	08.83
Ceramic filter (incorporating carbon odour remover)	12.60
Packing	00.30
Total	12.90
Sintered polyethylene	03.48
Plastic container	00.17
Container and caps	00.12
Packing	00.30
Total	04.07

4.9 Utility Requirements

Typical European prices per filter

- Electricity US$ 16,500 pa
- Water US$ 02,750 pa

These do not include heating or air conditioning running costs.

4.10 Annual Maintenance Costs

These should be low in Year 1, rising to an ongoing rate in Year 3. Typically these will be under 10% of the overhead costs, i.e. under US$ 0.19 per water filter based on Year 3 potential output.

4.11 Manpower requirements

The following outline workforce can be increased as volume production builds up but this skeleton workforce is all that the business can support in the formative years.

General Manager

Will have production engineering, financial and personnel management skills. Qualified chartered engineer.

Sales Manager

Basically a working salesman typically with a technician qualification and 5 years selling experience.

Accountant/Book-keeper

General understanding of book-keeping up to trial balance. Basic qualification in accountancy.

Office Staff (2)

Internal sales duties. General school education.

Production Engineer

Experienced in continuous production work. Qualified technician grade engineer with 5 years relevant experience.

Foreman

Must have engineering trade skills and have served an engineering apprenticeship.

Maintenance Fitter

Must have engineering trade skills and have served an engineering apprenticeship.

Operators (7)

General factory skills, but not trade skills.

4.12 Pre-Production Costs

It is assumed that this operation will be set up either as a licence operation or as a know-how deal.

The following fee structure is assumed as it will give good support during commissioning and during susequent phases of the project:-

Initial pre-production fee for plastic technology	US$ 100,000
Initial pre-production fee for textile filter technology	US$ 100,000
Ongoing Royalty fee including fees for updating product range and processes	5% of ex-works price

4.13 Initial Production levels

The following are based on two extrusion machines producing components for 1,000 complete units per week and components for incorporating into 4.000 replacement filters per week per shift.

Year	Complete Units	Replacement filter elements
1	20,000	150,000 (1 shift)
2	40,000	300,000 (1.5 shifts)
3	50,000	500,000 (2 shifts)

4.14 Construction Period

Buildings	22 weeks
General plant and machinery	16 weeks
Shipping	22 weeks
Installation	30 weeks
Commissioning	34 weeks
Production run-up	38 weeks

4.15 Environmental aspects

There should be no abnormal environmental problems. Conventional waste tips shouid be satisfactory.

5.0 PRODUCTION COSTS

These are estimated as cost per complete filter unit and replacement element based on a production of 50,000 complete filter units and 500,000 replacement filter elements per annum by the end of year 3:-

	Standard Filter		Filter for Odour Removal	
	Complete Unit	Replacement Element	Complete Unit	Replacement Element
	US$	US$	US$	US$
High Pressure Unit				
Material	04.33	0.43	05.00	1.10
Labour	00.88	0.09	01.08	0.29
Overhead	01.94	0.19	02.38	0.63
Gross Profit	14.85	0.57	17.89	2.02
Factory Selling Price	**22.00**	**1.28**	**26.35**	**4.04**
Royalty	01.10		01.32	
Factory Selling Price including Royalty	**23.10**		**27.67**	
Low Pressure Unit				
Material	03.53	0.43	04.20	1.10
Labour	00.88	0.09	01.08	0.29
Overhead	01.94	0.19	02.38	0.63
Gross Profit	06.15	0.57	07.66	2.02
Factory Selling Price	**12.50**	**1.28**	**15.50**	**4.04**
Royalty	00.63		00.78	
Factory Selling Price including Royalty	**13.13**		**16.28**	

Material costs include delivery to the factory of the raw materials.

Labour costs are for direct staff, which comprise production engineer, foreman, and operators plus production staff in the offices. Factory Overheads include indirect and additional staff costs, local taxes, utilities, plus factory administrative costs but exclude advertising. Selling costs are assumed to be paid from gross profits.

6.0 INTERNATIONAL PRICES

Typical international retail prices of water filter units are:-

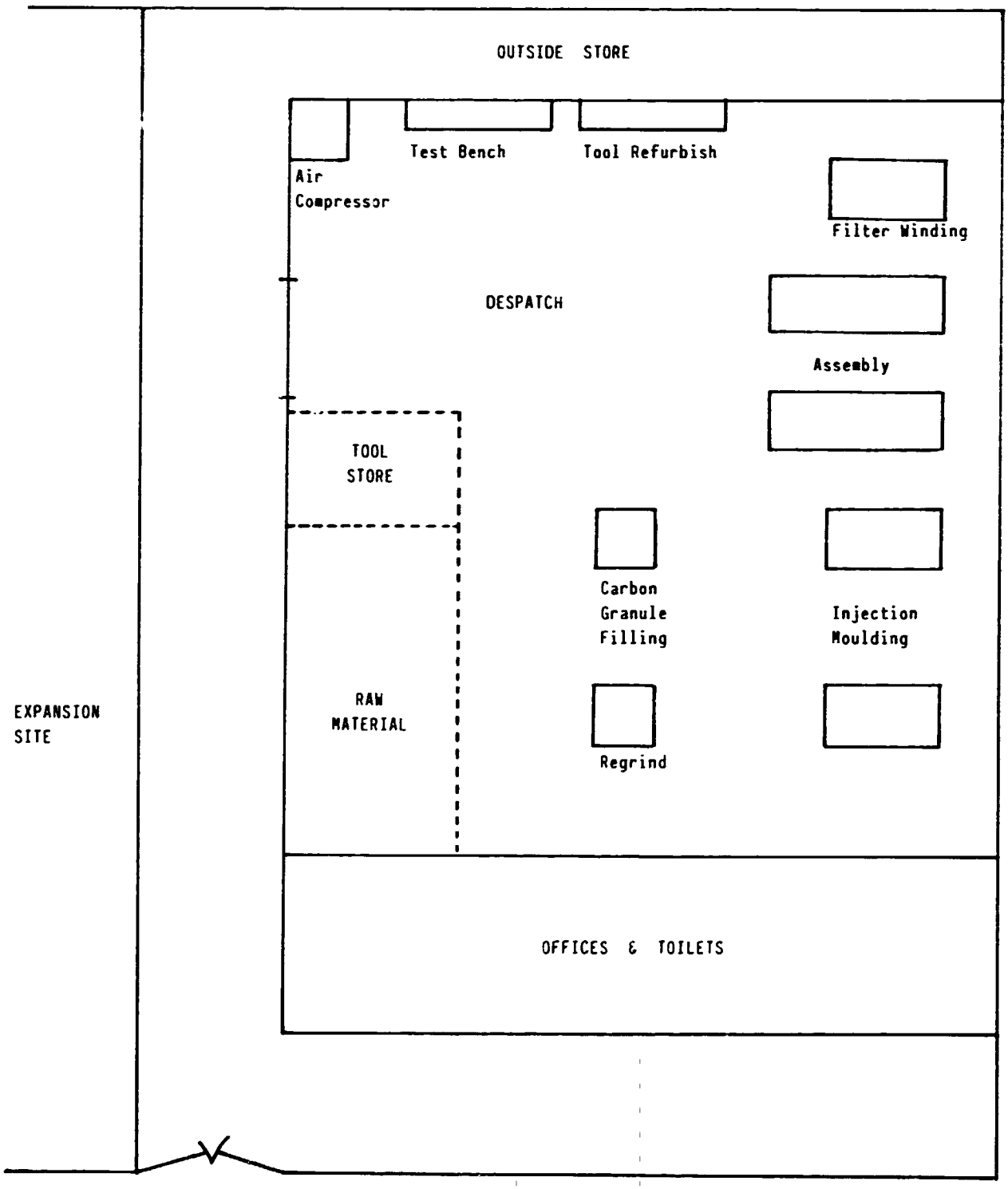
	Retail Price	Factory Selling Price (includes Royalty)
	US$	US$
High Pressure Unit		
Textile Filter	41.60	23.10
Textile + odour filter	49.81	27.67
Low Pressure Unit		
Textile filter	23.63	13.13
Polyethylene	29.68	16.49
Ceramic filter	37.12	20.62
Textile + odour filter	29.30	16.28
Replacement Filter Elements		
Textile	09.50	05.28
Polyethylene	15.55	08.64
Ceramic	22.99	12.77
Textile + odour removal	15.17	08.40

These prices are high when compared with the production costs listed in Section 5.0. To achieve the volume sales proposed the associated promotion and

marketing costs will be high and have been estimated to be US$ 1,440,000 in Year 3 (US$ 5.5 per unit).

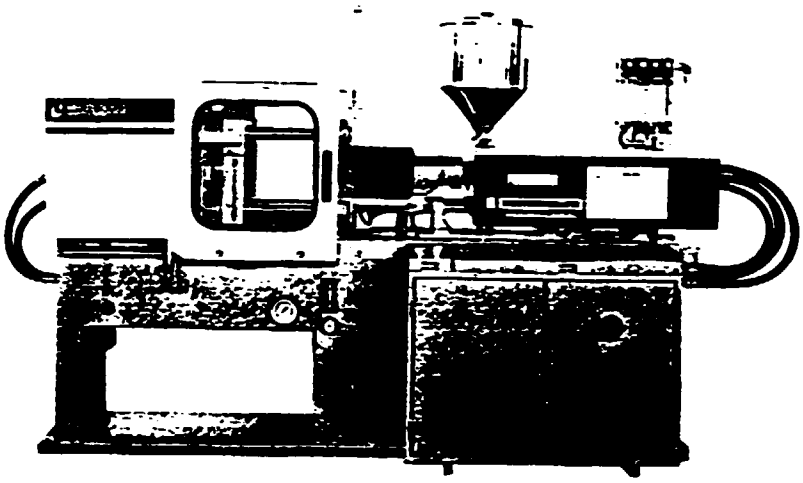
The in-line water filter is likely to take over from the traditional 'free standing' water tank with in-built filter which is still to be found in many parts of the Arab Gulf region. The trend in Europe for almost any consumer product is to move away from free standing units towards fully fitted units. This has proved to be particularly true where plumbing is involved.

APPENDICES



Scale: 1cm = 2m

WATER FILTER FACTORY LAYOUT



INJECTION MOULDING MACHINE

TECHNICAL PROFILE DATA REQUIREMENTS
ASSESSMENT AND SUMMARY SHEET

Product(s) : Water filters and Replacement Elements

Capacity :

Number of Shifts : 1 in Year 1; 1.5 in Year 2; 2 in Year 3.

Number of working days/years : 240

Production output by product (incl. efficiency ratio) (Year 3):-

500,000 Complete units (95%)

500,000 Replacement elememts (95%)

INVESTMENT - US DOLLARS [Basic Sxchange Rate Used US$1.0 = QR3.65]

- Plant/machinery (FOB):
  - * Main production plant/machinery (1) : 543,000US$
  - * Storage equipment : 040,000US$
  - * Auxillary equipment : 050,000US$
  - * Packaging equipment : 006,000US$
  - * Pollution control equipment : included in building
  - * Engineering/Design fees (if required) :

  - * Sub-Total of abuve 639,000US$

(1) Note Separate detailed schedule of plant/machinery items to be attached.

- Spare parts (1 year):
  (initial set as inventory for working capital) : 033,000US$

- Erection costs : 060,000US$

- Freight charges (to Arab Gulf Port) : 033,000US$
  (estimate)

- Site and Building reqirements (M2)
  - o Production Area : 0550
  - o Warehouse Area : 0100
  - o Office Area : 0150
  - o Hardstanding Area : 1200

    Total site land : 2000

- Transport equipment : 003,000US$
  (if available)

- Furniture and fixtures : Estimated by GOIC
  (if available)

- Pre-production expenses (consultant component estimates)
  - o Training
    - * Fees : included in licence fee
    - * Number of persons : 6
    - * Period : 2 weeks each
    - * Location : Europe

      Sub Total Cost : included in licence fee
  - o Travel expenses : 042,000
  - o Commissioning : 048,000
  - o Studies (if required) : 020,000
  - o Licence fee (if required) : 200,000

    TOTAL : 310,000US$

- **Construction programme**

  (Total in calendar months preferable with bar chart diagram).

o	Engineering /Design	4 months prior to start
o	Delivery/Equipment	5.5 months
o	Buildings	5.5 months
o	Installation	2 months
o	Commissioning	2 months

	TOTAL	13.5 months

- **Production programme**

  (Production achievable after commissioning in %)

o	First year of production	35
o	Second year of production	66.7
o	Third year of production	100

PRODUCTION AND OPERATING COSTS

- **Raw Materials:**

Product	Quantities /year	Prices (US$/T)
Opaque plastic	142 tonnes	01,260
Clear plastic	080 tonnes	01,360
Textile yarn	009 tonnes	04,430
Ceramic	Factored item	
Polyurethane	044 tonnes	13,800
Activated carbon granules	025 tonnes	01,000

- **Consumables:**

(i.e. Chemicals and other materials)

Product	Quantities / year	Prices (US$/T)
Packaging	138 tonnes	01,355
Consumables	.09/unit	
Scrap		

- **Royalties:** 5% of ex-works price/year.

- Utilities (**) PER YEAR. (Excluding building and air conditioning).

  - o Fuel : -
  - o Process water : 024,000 L
  - o Electricity : 153,000 KWh
  - o Steam : -
  - o Cooling water : -
  - o Compressed air : 700,000 L
  - o Gas (***) : 002,000 KG (LPG - Fork lift truck)
  - o Gas oil : -

(**) Unit (Kg, T, m^3...) per unit of product or per year.

(***) Natural, LPG etc. (please define).

- **Maintenance cost:**

(including spare parts, excluding local manpower)

4% equip. + 3%bldg.

- Labour (by relevant skill and categories):

Production (a)	No./Shift			Administration	No.
	1.5	2	3		
Prod. Engineer	1			General Manager	1
Supervisor	1			Dept. Head	1
Technician	1			Accountant	1
Skilled workers	2			Secretary	1
Semi skilled workers	5			Driver	1
				Employee (skilled)	2
Total	10			Total	7

(a) Includes Maintenance Personnel.

International Sale Prices (By product): US$

Complete Unit (Filter)	Ex-works	Retail
Standard textile filter	13.13	23.63
Standard poltethylene filter	16.49	29.68
Standard ceramic filter	20.62	37.12
Standard carbon/textile filter	16.28	29.30
Replacement Element (cartridge)		
Textile element	5.28	09.50
Polyethylene element	8.64	15.55
Ceramic element	12.77	22.99
Carbon textile element	8.40	15.17

It is anticipated that Arabian Gulf costs and prices will be generally similar to West Europe.