On behalf of all of the CLEXTRAL Group’s personnel, I wish you all the very best for the coming year 2006. This will be a special year as we celebrate the 50th anniversary of TWIN SCREW technology at Firminy with you.

Our New Year’s resolution is to be even more responsive and accessible to you: 2006 will see the creation and development of the CLEXTRAL SERVICES GROUP, combining the SERVICE resources, skills and expertise of our 4 business sectors: TWIN SCREW, DKM, AFREM and LYMAC under the skillful guidance of Georges Hallary. We are sure that this multitalented and dynamic “Services” team will provide total satisfaction.
“CLEXTRAL Services was created in September 1992: a close-knit and dedicated group whose main vocation was the satisfaction of CLEXTRAL extruder users.

Today, we are proud to say that this initiative has been a solid success with customers: user questions are readily answered, machine performance has improved, operator and maintenance staff skills have increased, maintenance costs have lowered, and on top of all this, customers can count on a recognised team, always ready to help.

The success of the preventive maintenance, user training and CLEXTRAL extruder improvement programmes has also inspired users of competing hardware, who have expressed their desire to implement CLEXTRAL solutions on their extrusion systems.

Now, building on their 13 years of experience, the CLEXTRAL Service team has expanded to incorporate the manpower and skills of CLEXTRAL partners, AFREM, LYMAC, and DKM, to become the CLEXTRAL Services Group.

CLEXTRAL Services Group now deploys its know-how and resources throughout the world. Its network, established in the USA, Chile and China, enables it to be even closer and more responsive to our international customers.

The forthcoming opening of subsidiaries in Sao Paulo, Algiers and Moscow will further extend this Service network. The reinforcement of our teams in France and the USA (6 new positions pending!) will increase our responsiveness and our intervention capability on customer premises.

We never forget that Service is first and foremost a question of Understanding and Communicating. Continual effort is made to ensure that fluent English, Spanish, Portuguese, German, Italian, Arabic, Russian and Chinese are spoken within the group.
Lastly, establishing CLEXTRAL Services Group as the fifth column of Group business, directly answerable to Group Management, demonstrates our commitment to be close to our customers, to listen to them, to assist them and to develop Services and tomorrow’s technology with them.

Winning together: that is our vision of the future.”

Breakfast is an essential part of a well-balanced diet; it is estimated that it should represent 20 to 25% of the total daily Energy consumption for children and 15 to 20% for adults.

It consists of a main carbohydrate source (fast and slow absorption), low in lipids and represents a good source of fibre, vitamins and minerals.

Prepared breakfast cereals combined with a drink, a dairy product, and a fruit meet this requirement.

Breakfast cereals debuted at the end of the 19th century, and cereal styles advanced throughout the 20th century as manufacturers in Europe and America worked to develop new products and processes. As technology improved, the range of prepared cereals evolved from simple cooked oats and cooked flaked corn to sophisticated products including flaked and direct expanded cereals. Today, cereals may be vitamin rich, high in fibre content, sugar and syrup coated, chocolate flavoured, in many appealing shapes. Müsslis (blend of flakes, nuts, fruit, sugar, and other ingredients), co-extrudates (crisp shell with a soft filling), and granola bars (agglomerated and roasted cereals) belong to this large family as well.

It is estimated that over 5 million metric tonnes are consumed annually, with steady growth worldwide. Due to health and nutrition concerns, consumers are seeking products with high added value.
CLEXTRAL pioneered twin screw extrusion technology for breakfast cereals in the early 1970’s, introducing a process that was faster, simpler and more economical than the traditional batch process:

- a manufacturing time of 30 minutes against 6 to 7 h (flakes),
- a reduced space requirement,
- a continuous production system which can be automated,
- quick start up, shut down and cleaning procedures,
- possibility to switch easily from one product to another,
- simplified maintenance operations,
- very large range of processed raw ingredients.

Twin Screw Extruders (TSE) are processing machines consisting of two identical co-rotating, intermeshing, self-wiping screw profiles operating within a closed barrel.

The TSE is a continuous mixer/cooker/former, which performs a positive pump action; it can operate at high pressures and high moisture levels, and does not rely on internal friction between the screws and barrel to convey the cooked mass towards the die. It can process a variety of particle sizes while maintaining uniform product shear and production flow.

Flaked or expanded products made from various grains are easily produced in the same plant, using the same extruder and barrel configuration and ancillary equipment upstream, (feeder, preconditioner, liquid injection) and downstream (flaker, toaster, coating unit, ...etc).

Here is a description of the major steps and options in the extrusion of breakfast cereals:

- **Premix station**: a range of options are available for raw material handling systems, from sack tip to fully automatic bulk systems. This includes a weighing, mixing and preparation area for the ingredients, partially or fully automated to suit the individual processor’s requirements.

- **Preconditioning**: introduces extra steam and water to gelatinize the raw material making it soft and malleable; it is a gentle process that allows the raw materials to retain their natural flavour.

- **Twin screw extrusion**: cooks the ingredients with a combination of heat, mechanical shear and added moisture. If desired, liquids may be simultaneously added through a metering pump, such as a malt-syrup preparation. The temperature is accurately controlled in each section of the modular barrel by internal cooling channels and external heating elements. The screw configuration and die design are specific to non-expanded or expanded cereals. A post cutting system perfectly calibrates the nibs (for flakes) or the direct expanded products.

- **Flaking (for flakes only)**: after direct cutting at the exit die or through a nib cutter, the cooked but non-expanded nibs are tempered in a drum conditioner then flaked between two chilled steel rollers; product specifications such as stickiness and surface characteristics are controlled by adjusting the roll pressure on the product.

- **Toasting/drying**: the direct expanded products coming from the extruder or the flakes from the flaking rolls are fed into the dryer/toaster to reduce the moisture content to around 3%. Temperatures and residence times are not the same for direct expanded cereals and flakes; during this heat treatment, the flakes develop their specific blistering, crispy texture, flavour and colour.
- **Coating**: the dried or toasted products may be fed to a coating unit where a sugar-syrup preparation is applied in the required proportion. During or after coating, the products are dried then packed.

- **Packing**: a multi-weighing unit is often linked to a vertical bagger connected to a vertical cartoning machine; this system offers a fully automated and accurate packaging solution.

The CLEXTRAL group has installed over 150 breakfast cereal production systems throughout the world and provides engineering studies, equipment, process expertise, commissioning, after-sales service, local support and training. Two pilot plants are available in Europe and the USA to simulate industrial manufacturing and conduct new research in partnership with the customers. Processors trust the CLEXTRAL group to supply the technology, expertise and hands-on help in their quest for new techniques and fresh ideas in breakfast cereal production.

Innovation is a key issue within the CLEXTRAL group: as shown in the multi-purpose production line recently supplied to manufacture flakes, direct expanded products and co-extruded pillows on the same equipment.

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**INTERVIEW**

**Clex**: Can you explain why you decided to work with CLEXTRAL?

**Company MSC**, Industrial Director: after having analyzed and compared different technologies available on the market, we decided to work with the CLEXTRAL Group because of its experience that we observed in other companies who were using this equipment. CLEXTRAL’s unmatched references and know-how in cereal processing were key points. Moreover, we wanted a very flexible and multi-purpose line as we are producing expanded and flaked breakfast cereals as well as co-extruded products; CLEXTRAL provided the complete solution and we were confident that we could produce a high quality product line for our customers.

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**Clex**: What about the installation of the line?

**I.D.**: We received the requested equipment and conducted a successful commissioning. It is a challenge to produce very different types of breakfast cereals with the same line: here again CLEXTRAL provided full technical support, assistance and expertise to overcome all mechanical and process questions.

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**Clex**: Did your choice meet your expectations?

**I.D.**: Yes, indeed. We think that we made the right choice with CLEXTRAL; we have a firm partnership. During some complex operations connected to the process, we worked together to find the best solution to manufacture premium quality breakfast cereals at the requested capacity. This cooperation and the availability of local personnel resulted in a good experience that we would recommend: we feel confident and ready to develop new products for our market.

`thank you for your statement.`
INTRODUCTION TO A NON CONVENTIONAL INDUSTRIAL PROCESS FOR THE PULPING OF NON WOOD FIBRES & CROP RESIDUES

Background: In a previous issue of Clextrusion (Nr 12) we have seen how CLEXTRAL developed and sold worldwide a cost effective solution for producing paper pulp from cotton linters. We propose here to complete our presentation with the process operation of crop residues and non wood fibres such as wheat straw, bagasse, hemp, flax, …

The Bivis process offers new alternatives for manufacturing high quality pulp at reduced production costs, low pollution load, totally chlorine-free pulps and less water consumption.

1) Principle of the twin screw technology:

The Twin Screw Extruder (TSE), also called the BIVIS machine, consists of two identical, co-rotating and intermeshing screw sections fitted on splined shafts. The sleeve which houses the screws is split into two parts having a horizontal mating plane. The sleeve is fitted with easily removable protective liners and includes a number of openings for the injection of liquids and gases. The sleeve may be fitted with special filters for liquid extraction. The two screws are supported at their ends by two bearings and are driven by an electric motor.

Fibre separation or fibre cutting are achieved by compression and shearing forces due to reverse screw thread components called reverse sections. Several shearing modules are required for efficient fibre separation. Various chemical treatments may be performed by the TSE machine. Liquids or gases may be injected through the sleeves at different places. TSE is a very good and efficient mixer. The combined action of temperature and pressure, associated with the micro-mixing performed by the screws, accelerates the kinetics of the chemical reaction. A dwell unit is generally used after TSE machine treatment to complete the chemical reaction.

Washing operation: For chemi-mechanical or semi-chemical pulps, the TSE performs both washing and defibering simultaneously, using filters adequately located along with high pressure zones. A highly efficient washing is accomplished, giving substantial savings in washing water and much less effluent to be processed. Bleaching operations are easily achieved with TSE process, using sodium hydrosulphite and hydrogen peroxide: this process is totally chlorine free, and enables the manufacture of a high bleached pulp, with a small amount of bleaching agents and chemicals.
## 2) Non wood and crop residues TSE pulping process: examples

### Wheat Straw Pulping Process

#### MAIN operating parameters
- Electrical Energy (kWh/BDT): 600
- Steam (T/BDT): 0.5
- Chemical: Caustic Soda (%): 5
- Unbleached Pulp Yield (%): 80

#### Pulp properties
- Refining Index (°SR): 45
- Bulk (cm³/g): 1.3
- Breaking Length (m): 5110
- Tear Index: (mN.m²/g): 3.3
- Burst Index (kPa.m²/g): 3.8
- Concora Medium Test (N): 198
- Ring Crush Test (kN/m): 3.9

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### Bagasse Pulping Process

#### MAIN operating parameters
- Electrical Energy (kWh/BDT): 550
- Steam (T/BDT): 0.5
- Chemicals: Caustic Soda %: 10
- Chlorine %: 5
- Sodium Hypochlorite %: 7
- Unbleached Pulp Yield %: 83
  (Dephiting excluded)

#### Pulp properties (Valley beater refining)
- Refining index (°SR): 50
- Bulk (cm³/g): 2.2
- Breaking length (m): 5440
- Tear index: (mN.m²/g): 3.8
- Burst index (kPa.m²/g): 2.5
- Gurley porosity (sec/100ml): 30
- Brightness (%ISO): 80

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[Diagram of Wheat Straw Pulping Process]

[Diagram of Bagasse Pulping Process]
These examples show that the Bivis technology offers a combination of several operations for cellulosic raw material pulping. This process is particularly suitable for low or medium sized capacities, up to 120 BDT per day. This compact equipment doesn’t require sophisticated civil engineering, so a new pulping line may be easily erected as a green field unit or as a complementary pulping unit.

This economical pulping Bivis process is available worldwide, thanks to CLETRAL’s offices in China, USA and Chile and local support in 30 countries. Two pilot plants are at your disposal to demonstrate the benefits of the TSE : share our 30 years of Bivis process experience to gain quality and productivity!

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<table>
<thead>
<tr>
<th>MAIN OPERATING PARAMETERS</th>
<th>PULP PROPERTIES (Valley beater refining)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Energy (kWh/BDT)</td>
<td>1000</td>
</tr>
<tr>
<td>Caustic Soda (%)</td>
<td>7</td>
</tr>
<tr>
<td>Hydrogen Peroxide (%)</td>
<td>7</td>
</tr>
<tr>
<td>Bleached Pulp Yield (%)</td>
<td>75</td>
</tr>
<tr>
<td>Refining index (°SR)</td>
<td>60</td>
</tr>
<tr>
<td>Breaking length (m)</td>
<td>6500</td>
</tr>
<tr>
<td>Tear index (mN.m2/g)</td>
<td>10.5</td>
</tr>
<tr>
<td>Burst index (kPa.m2/g)</td>
<td>3.7</td>
</tr>
<tr>
<td>Brightness (%ISO)</td>
<td>80</td>
</tr>
</tbody>
</table>
On a worldwide scale, fishing represents a constant 90 million tons of fish against 50 million tons by aquaculture. This production is growing at a rate of over 8% per annum, well above the growth rate in livestock farming. As a result, almost half of the fish products eaten by man are derived from aquaculture (Fig 1).

The growth of aquaculture, especially in terms of finfish and prawns, has resulted in an increased need for composite foodstuffs, estimated at 18 to 20 million tons.

Reduction in the protein – energy ratio

Most intensive fish farming species are varieties with a “carnivorous” feeding habit. Given the nutritional requirements of aquatic animals, the foodstuffs used in aquaculture generally have a higher total proteinous matter (> 35% of dry matter) and fatty matter (FM: > 10%) content than those used for conventional field farming. It is important to optimize the digestible protein (DP) / digestible energy (DE) ratio. Research has shown that a reduction in this ratio would improve the nitrogenous matter usage with almost all fish (Cho & Kaushik, 1990), therefore, we have dedicated our efforts to optimising this ratio. Consequently, in salmon breeding we have seen a major reduction over the last 20 years in the DP/DE ratio from more than 20 to less than 15mg DP/DE kJ. This has been achieved by reducing the protein content in foodstuffs (from 50 to less than 40%) and increasing the energy content supplied mainly as fatty matter (level sometimes exceeding 35%). This progress has been achieved by extrusion technology: aquafeeds are processed by extruder, followed by coating with oil, this technique has gradually become widespread in production of aquatic feeds. This development has accomplished several objectives: reduced protein costs, lower nitrogenous waste and improved growth performance.
Changing over from fish flour

In aquafeed, the protein and lipid ingredients are generally supplied in the form of fish flours and oils. The excessive dependence of aquaculture on these ingredients, which are derived from dedicated fishing practices, justly arouses numerous questions as to the longevity of such practices. On a worldwide scale, the availability of fish resources is declining, and given the predictable increase in aquacultural requirements, the risk of shortfalls in these ingredients is quite real. For the preservation and optimal usage of natural fish stocks and the durable development of aquaculture, research into substitute flours and oils has multiplied in recent years.

Extrusion technology offers promise in the challenge of incorporating vegetable proteins into aquafeeds. Although these ingredients are generally rich in complex carbohydrates and difficult for fish to digest, research in the 80’s has proven that cooking-extrusion heat treatments enhance the digestibility of complex carbohydrates. Our own research has shown that the incorporation of cereals (wheat, corn, triticale), oilseed crops (peas, lupine) or oil seeds (Soya, colza), processed properly (cooking – extrusion, co-extrusion) improves the digestible energy in feeds, thus saving on food proteins. On the industrial scale, this optimisation of the protein / energy ratio has contributed to the development of less polluting or “ecological” feeds.

When using these vegetal ingredients, a major concern is the level of anti-nutritional factors that are present. As fish are generally more sensitive to these anti-nutritional factors than field animals, and as aquacultural foodstuffs are rich in proteins, it is essential that these factors be destroyed when processing aquafeed. In parallel with the development of low anti-nutritional factor vegetal genotypes (e.g. Primor 000 or canola from colza), the appropriate technological processing (dehulling, cooking-extrusion, co-extrusion, micronisation, etc.) now enable us to obtain vegetal products with an extremely low anti-nutritional factor level. Extrusion thus allows us to reduce the anti-trypsinogen factors and improve the protein digestibility and availability of soya amino acids (Cheng and Hardy, 2003).

A growing stream of data is proving that it is possible to greatly reduce the use of fish flours by using vegetal sources for certain species, including the rainbow trout (Kaushik et al. 1995), European seabass (Kaushik et al. 2004) and Gilthead seabream (Sittja-Bodadilla et al. 2005). There are dual benefits to this practice: aquaculture can integrate and recycle vegetal raw materials resulting from agriculture (cereals, oil crops or oil seeds), and preserve vital marine resources.

In aquaculture, the other technological challenge is creating a variety of feeds for different stages in breeding (different diameters of granules, from a few microns to over 15 mm) with the required physical properties for zootechnical reasons (mechanical resistance to handling and agitation in water, ability to absorb water, sink or float). These requirements demand major adaptations and specific operations. Extrusion allows the modification of physical characteristics of granules to enable greater stability in water and enhanced availability of essential nutritional elements. These advantages make extrusion a vital technology for aquaculture feed production, as well as for fish farming in ponds or prawn production.
References


For the last 25 years CLEXTRAL has been a major player in the field of aquaculture, with the sale of its twin screw systems for fish farming applications in the end 70’s in France and Scandinavia.

The common determination shared between CLEXTRAL, industrial companies and research institutes led to the massive development of this technique in the field of aquaculture, in particular for salmonids.

In 1983, the INRA published results (1), followed by IFREMER and INRA in 1986 (2); these institutes as well as others such as the SINTEF at Trondheim (Norway) laid down the fundamental scientific grounds for twin screw extrusion. At the same time CLEXTRAL, in cooperation with the food manufacturers invented specific devices and immediately applied the results of this research by developing new and increasingly efficient production lines.

In turn, the scientists used these new tools to develop recipes adapted to new species of fish and shrimps.

To date, CLEXTRAL has installed 70 manufacturing plants throughout the world for aquaculture, including 16 installations producing over 10 tonnes per hour of pellets.

CLEXTRAL is continuing its development work to produce systems which are even more competitive, reliable and easy to use, designed to accurately control pelot density and manufacture products with high fat contents according to demands, perfectly calibrated and adapted to the nutritional requirements of the animals.

Two test stations in Europe and in the United States are available to demonstrate the possibilities of these installations and develop new products.

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IN BRIEF

50th ANNIVERSARY OF THE CLEXTRAL GROUP

The CLEXTRAL Group will celebrate its 50th anniversary in October 2006. Fifty years of Service, Innovation and Quality dedicated to our customers and partners!

In celebration of our anniversary, the CLEXTRAL Group will host an international symposium on “Health and Wellness;” introducing advanced scientific and technological information specific to CLEXTRAL group customers’ interests in processing and packaging.

QUALITY MANAGEMENT

The ISO 9001 (2000 version) certification has been renewed, confirming that CLEXTRAL complies with the latest norms of quality management. This certification once again recognizes CLEXTRAL’s continuous commitment to quality and acknowledges the contribution of all CLEXTRAL employees.

The ISO 14001 certification has been satisfactorily conducted at CLEXTRAL: we will return to this point in an upcoming issue of Clextrusion.

SHOWS AND EXHIBITIONS

You can meet the CLEXTRAL Group teams during a number of shows in 2006:

- **Ipakc IMA**
  - Milan - ITALY
  - 14-18 February 2006

- **FOTEG**
  - Istanbul - TURKEY
  - 23-26 February 2006

- **VICTAM Asia**
  - Bangkok - THAILAND
  - 8-10 March 2006

- **EMPACK**
  - Lille - FRANCE
  - 16-17 March 2006

- **SNAXPO**
  - Las Vegas - USA
  - 20-22 March 2006

- **AACC Food Extrusion Course**
  - Saint Etienne - FRANCE
  - 20-22 March 2006

- **AQUA SUR**
  - Puerto Montt - CHILE
  - 22-25 March 2006

- **DJAZAGRO**
  - Alger - ALGERIA
  - 27-30 March 2006

- **AGROLIBYA**
  - Tripoli - LIBYE
  - 2-12 April 2006

- **ANUGA foodtec**
  - Cologne - GERMANY
  - 4-7 April 2006

- **EMBALLAGE Rhône Alpes**
  - Lyon - FRANCE
  - 12-13 April 2006

- **Food processing & Foodpack**
  - Malmö - SWEDEN
  - 10-11 May 2006

- **ISFNF**
  - Biarritz - FRANCE
  - 28 May - 1st June

- **IRAN AGRO FOOD**
  - Téhéran - IRAN
  - 28-31 May 2006

- **FOOMA**
  - Tokyo - JAPAN
  - 6-9 June 2006

- **IFT**
  - Orlando - USA
  - 24-28 June 2006

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