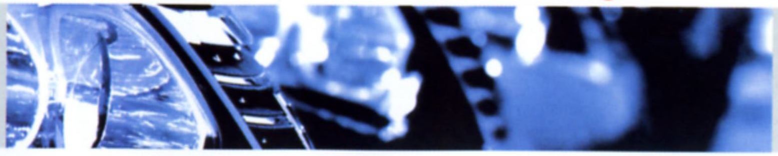
Applications and **Case Studies**

IMC is suitable for a wide variety of applications, which could include:

- **Air conditioning**
- **Agitators**
- **Baggage handling**
- **Bottling lines**
- **Circular saws**
- **Compressors**
- **Conveyors**
- **Crushers**
- **Die-casting machines**
- **Drying plant**
- **Escalators**
- **Extruders**
- **Fans**
- **Feed rollers**
- **Granulators**
- **Grinders**
- **Injection-moulding**
- **Hydraulic systems**
- **Machine tools**
- **Mixers and blenders**
- **Pager refiners**
- **Pulpers**
- **Presses**
- **Printing machinery**
- **Pumps**
- **Sewing machines**
- **Vacuum-forming**
- **Weaving and knitting**

Study 1: Plastic Injection Moulding



Manufacturer of Plastic Automotive Components

IMC units were attached to a number of Plastic Injection Moulding Machines producing automotive components. The following extract from the Facilities Manager's letter to the Distributor clearly illustrates his satisfaction at the performance of **IMC**

> "The introduction to your product and the benefits indicated in the survey carried out were difficult to believe and had I not seen them myself I also would have doubted the benefits indicated. The main usage of electricity within my company is on injection moulding machines. They account for approximately 40% of the total electricity consumption. The total overall electricity bills subsequent to installing **IMC** on all the machines, have shown a reduction in excess of the 5% that I had budgeted. Some of the moulding machines indicated a saving more than 20%. I have tried various other means of reducing power usage but none have given the benefits of yours. In addition to the cost reduction, the motors run cooler and quieter and this in turn will result in fewer motor failures and down time."

Study 2: Chiller Compressors

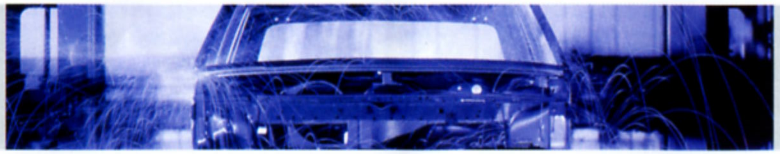
International Hotel Chain's Chiller Services

IMC was recently piloted on the Chiller Compressors at one of the Australian locations of an international hotel chain. This project was carried out on a 220kW Trane Chiller with four 55kW compressors. Trane engineers themselves disengaged two compressors and re-set the remaining two to run concurrently. An **IMC** unit and a three phase energy analyser were installed on one of the remaining 55kW compressors and a three phase energy analyser only to the other; thus enabling the capturing of the running characteristics of two identical compressors under the same load conditions on a "With" and "Without" **IMC** scenario.

It was noted that the Chiller compressor "without **IMC**" was regularly under full load between 12noon and 1pm every day. It would generally be assumed that this high loading was caused by usage of the Chiller unit in chilling goods. This would imply that the compressor is working efficiently and hence limited potential for energy savings.

> Surprisingly however, the Chiller compressor "with **IMC**" demonstrated greatly reduced loading at these same times. The testing data demonstrated that prior to **IMC**'s installation much of the cooling, which was happening during these high load periods, was to remove latent heat from the system generated by the motor windings themselves and not to chill the food being stored; delivering a 16% reduction in reactive load (kVar). "With **IMC**" the refrigeration circuit was running more efficiently with less latent heat being generated by the compressor's windings. In addition to a dramatic increase in the efficiency of the system, a saving of 10% was made in kW. It was commented that this saving allowed the hotel to effectively run the Chiller unit for one month each year for free!

Study 3: Fly-Wheel Presses



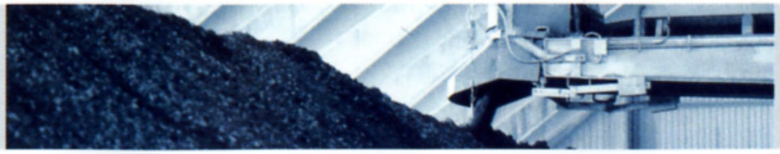
Automotive Component Manufacturing Plant

Effective management of costs is vital in the highly competitive world of automotive component manufacturing. A leading North American components manufacturer supplying the likes of GM, the Ford Motor Co and Daimler Chrysler has recently trialled **IMC**. The company is acknowledged for its technology, product design, service and delivery. It is therefore evident that the benefits from **IMC** in reducing energy, maintenance costs and downtime are valuable as part of a wider energy and cost management program. Additionally, **IMC** helps meet the aims from the company's ISO environmental policy which states that they "will continuously improve and review our practices and processes in pollution prevention and waste reduction".

The company's facility features metal presses sized from 100 to 1600 ton capacity; producing hinges, glove box doors, exhaust manifolds and underbody parts. **IMC** was installed on a 30kW motor powering a metal press. In addition to reducing a previous starting current of approximately 400amps to a maximum peak of 130amps, the energy savings were 30% when operating under its normal duty cycle. The readings taken showed that the 30kW motor only reached a usage of 15kW even under load. The savings generated equate to a payback of 20 months in energy savings alone, in addition to the peak demand and maintenance benefits from the controlled soft start.

The company has been using **IMC** technology on it's press lines for over 16 months. **IMC** units have been installed on press motors ranging from 22kW to 75kW. The installations to date display operational energy savings from 18% - 30% respectively. It should be noted that the **IMC** savings were validated by an independent power company. Furthermore, thermal image testing was performed on the motors whereby **IMC** reduced the operational temperature by over 15˚C.

Study 4: Conveyors



Calcified Seaweed Processing Plant

The Cornwall Calcified Seaweed Company is an established family business processing commercially dredged seaweed to produce agricultural fertilizer for grazing land. Their prime consumption of electricity within the family is through the use of conveyors, which transport the calcified seaweed from the quay into the main building, where it is dried and bagged for distribution. Prior to use with **IMC**, no soft start was in operation and associated maintenance issues were therefore apparent, in addition to the typical peak demand penalties.

A trial **IMC** installation was undertaken on two conveyors within the seaweed facility. The conveyors are hopper fed, which creates a continual but partial load. When the results were measured using a high quality 3-phase analyser, it was identified that kW savings obtained were 38%, which equated to a return on investment of just over 18 months. **IMC** has a special feature termed 'Broken Belt Protection'. In the event of conveyor belt breaking, the unit will sense the change in load and shut off the motor. This not only has a maintenance benefit, but could also have Health and Safety benefits. Cornwall Calcified Seaweed have confirmed their satisfaction with both the product and its trouble-free operation. Although this is a relatively small processing facility, they are looking forward to installing **IMC** on their other conveyors.

> “We have successfully installed **IMC** units on all of our conveyor systems for over two years without any downtime in production due to machine repairs. We are also enjoying tremendous energy savings.”

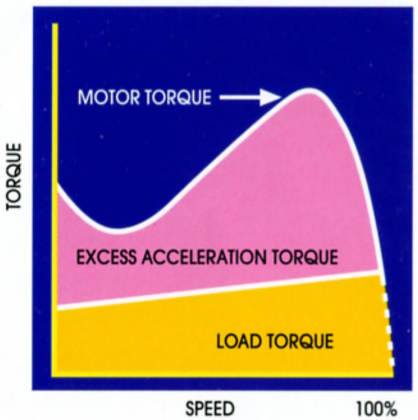
Managing Director,
Cornwall Calcified Seaweed

Technical **Overview**

Three Phase Induction Motors

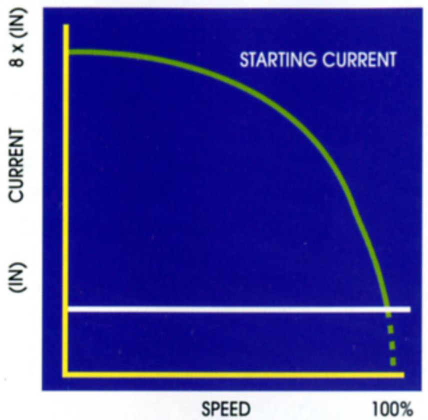
Since its invention one hundred years ago, the standard 3-phase induction motor has become one of the most familiar items of industrial equipment ever known. Due to its simplicity of construction, low cost, reliability and relatively high efficiency, it is likely to remain the prime source of mechanical energy for the foreseeable future.

The main problems are the motor's inability to match motor torque to load torque both during the high starting current and normal running.



During starting the motor usually produces 150-200% torque accelerating the load to full speed in a fraction of a second, which can cause damage to the drive train.

At the same time the motor can commonly draw 8-10 times nominal current (In) causing supplies stability problems.



When the motor is operating at light load for extended periods, the motor's efficiency falls due to the over-fluxing of the windings for the particular torque required to drive the load. At a constant terminal voltage this flux, often referred to as magnetizing current, is fixed and accounts for around 30-50% of the motors total losses.

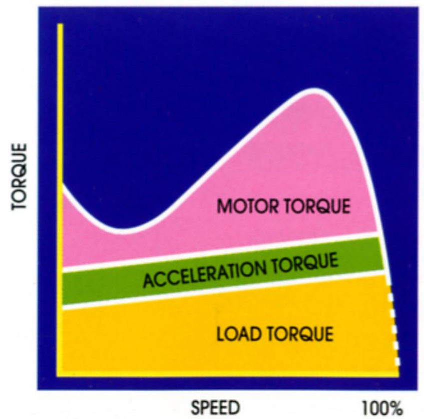
Soft Start & Soft Stop

IMC has a selection of ramp times to provide controlled acceleration and deceleration of motors and can effectively control the current without the levels of harmonic distortion normally associated with inverters. There are numerous problems associated with starting and stopping AC Induction motors - all of which can have serious implications if not rectified.

IMC has an unrivalled ability to change the shape of the applied voltage waveform, thus reducing the impact of the standing losses existing in all AC Induction motors. In common with conventional soft start devices **IMC** uses thyristor's to accurately control the voltage applied at the motor terminals. A characteristic of the thyristor is to switch rapidly from "OFF" to "ON" when pulsed, and to remain "ON" until the current through the device falls to zero at the end of each half-cycle in the AC supply, this is called self commutation.

The Control Technology

By controlling the switch-on point relative to the voltage zero crossing in each half cycle of the supply, it is possible to regulate the current flowing through the thyristor. The closer the turn-on point is to the end of the cycle the smaller the value of current that will be allowed to flow. Conversely, the closer the turn-on point is to the beginning of the cycle the higher the value of current will be.



Using this principle, and by connecting two thyristor's in anti-parallel to each of the phase connections to a motor, **IMC** can continuously adjust the voltage to the motor terminals by precisely controlling the thyristor's turn-on points. This provides just sufficient voltage for the motor to accelerate the load.

So, for instance, by starting with a large delay to the turn on point in each half cycle, and progressively reducing it over a selected time period, the voltage applied to the motor starts from a relatively low value and increases to full voltage. Due to the motor torque being proportional to the square of the applied voltage, the starting torque increases in a stepless manner ensuring a soft start for both the motor and the driven load.

Optimization

Continuous dynamic control is applied to the motor by a microcontroller embedded with **unique** software. Thyristor phase control is used to vary the motor terminal voltage in response to changes in motor loading. By reducing the terminal voltage of a motor under light or variable loads, it is often possible to reduce the magnetic core saturation, and copper winding losses, thereby increasing overall motor efficiency - saving on electricity costs.

Any variation of load, up or down, is automatically compensated for by changing the output from **IMC** to satisfy the change of circumstance. Because **IMC** is an intelligent device which serves the specific needs of each motor, you must install one **IMC** on each motor. Parallel connections are ineffective.

Suitable Applications

IMC can be installed on any Caged Rotor (squirrel cage) AC Induction motor. These represent the vast majority of motors in use in commerce and industry. **IMC** can be installed 'direct on line' or in line with an existing wye-delta starter. The suitability, and relevant benefits, are determined by the application and duty cycle of the motor.

Although a fully loaded motor is an ideal soft start application, a motor which is providing the power to it's intended maximum most of the time has no scope for optimization. Although at less than 70% load there is a possibility of some savings, in general it is below around 50% full load, where motor efficiency begins to fall off significantly, that **IMC** offers scope for substantial savings.

The UK energy efficiency office has stated that 'typically, industrial motors work at only 50% of rated capacity'. In many situations motors run continuously at low load because they are sized to handle a maximum loading condition that is rarely encountered. This is due, in part, to fluctuations in power supplies, safety margins in manufacturer's specifications, availability and stocking of motors in set sizes and variations in duty cycle.

High Efficiency Motors

IMC can be fitted to a High Efficiency Motor and provide superb control over the starting and stopping of the motor, furthermore it is still possible to deliver an additional saving in overall energy consumption. High Efficiency Motors reduce the impact of the Iron Losses of the motor, which are always present. High Efficiency Motors provide a fixed saving across the range of the motor's load. **IMC** will accept the fixed saving and then dynamically change the effect of the Iron Loss thus reducing the impact of that Iron Loss, yet further, as the load changes.

Power Factor

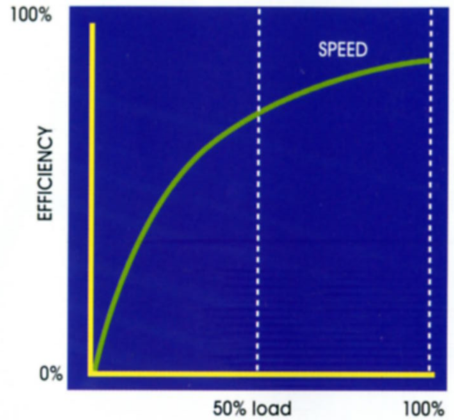
It is widely recognized that the use of AC Induction motors is the single greatest cause of reactive power, thereby producing a poor power factor. Reactive power is a characteristic of the inductive element of the motor. When a motor is fully loaded it will be running at its optimum efficiency and the load will be more resistive than inductive, hence, it will have a better power factor. However, as the load is taken off the motor it will become more inductive and therefore the power factor will become much worse.

IMC will incrementally improve the Power Factor or CosØ at the motor. This will have the effect of nullifying the need for the Power Factor correcting devices. It should be remembered that whilst AC Induction Motors affect the Power Factor of a system other inductive loads may still exist, which will still need Power Factor correction.

Motor Efficiency

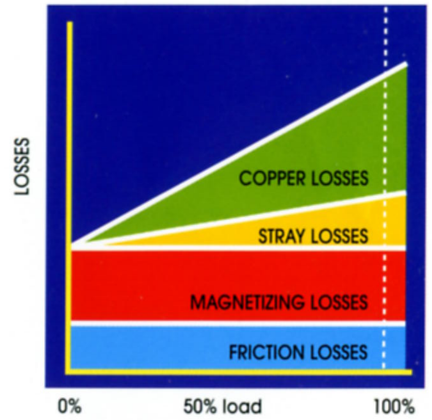
When working at or near full load, the typical 3-phase induction motor is relatively efficient, achieving efficiencies of between 80% and 92%. However, as shown in the graph below, motor efficiency falls dramatically when the load falls to less than 50% of rated output.

In fact, very few motors actually experience consistent fully rated operation, the vast majority operate at much lower loads due to either over-sizing (a very frequent situation), or natural load variations.



In applications where motor speeds do not need to be varied, the optimization software in the **IMC** will produce energy savings in lightly loaded motors.

Less sophisticated soft-starters remain at full conduction and the motor then behaves as if it were connected directly to the mains supply. However, at light loads at full mains voltages, induction motors always have excess magnetizing current as shown in the graph below. By detecting the load at any instant, and adjusting the motor terminal voltage accordingly, **IMC** is able to save some of the excitation energy and load loss. This will improve motor Power Factor to a greater extent when the motor is running inefficiently at light loads.



Because **IMC** 'electronically sizes' the motor to it's job of work at any instant in time it means that the motor is always working under it's ideal full load condition. This means that with **IMC** installed, a motor will be operating closer to 100% efficiency all the time.

IntelSteer
efficiency in electrical energy

In practice **IMC** has proven to be one of the best methods of providing reliable, economic control of motors, and for many companies is the preferred choice over conventional Soft Starters and Inverters.