

“Commercial-scale chemical production at pilot-scale size and cost.”

The Science of Process Intensification – Designed to Make an *Impact*

THE SCIENCE OF

Process Intensification

PI MAKES SIGNIFICANT ADVANCEMENTS IN THE EFFICIENCY OF CHEMICAL REACTIONS CREATING SUBSTANTIAL BENEFITS FOR INDUSTRY.

THE CAPITAL BUDGET FOR A PI FACILITY CAPABLE OF THE SAME OUTPUT AS A TRADITIONAL PLANT IS ONLY 10-25% OF THE FUNDS NORMALLY REQUIRED.

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A TRANSFORMATIONAL TECHNOLOGY

Process Intensification, or PI, is a revolutionary approach to process and plant design, development and operation that involves both equipment and methods. PI makes significant advancements in the efficiency of chemical reactions creating substantial benefits for industry. PI does not change chemical reactions, it makes them dramatically more efficient, faster and of greater consistency. **The benefits of Process Intensification are so significant they challenge business models**, have the potential to disrupt supply chains and provide for cleaner and safer operations.

This paper describes the primary drivers of Process Intensification and how PI solutions from Technology Investment & Development (TID) can help industry capture the benefits and have a dramatic positive impact on financial metrics and business strategy.

THE BENEFITS OF PROCESS INTENSIFICATION

The primary drivers for PI innovation include the promise for reduction in feedstock cost from improved yields, lower capital expenditures, lower energy use and higher quality outputs. PI involves the use of specialized pieces of equipment, advanced controls and new catalysts to generate high-efficiency kinetics and chemical reactions. The benefits of Process Intensification include the following:

SMALLER PLANT FOOTPRINT. PI can increase chemical rates of reaction by a factor greater than 10, and as a result PI equipment requires substantially less space than traditional chemical and hydrocarbon processing plants. For example, the operational footprint of a typical oil refining facility that can generate outputs of 70 million tonnes per year requires approximately 39 acres of land, however, a PI solution producing the same output volume can be fitted into a trailer-mounted configuration that requires only one-third of one acre.

REDUCED CAPITAL INVESTMENT. Smaller plant size translates into lower capital investment. In most applications, the capital budget for a PI facility capable of the same output as a traditional plant is only 10-25% of the funds normally required.

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**The CUBE: Increase Profits
More than 100%**



LOWER OPERATING COSTS. More efficient chemical reactions and a dramatically reduced facility size means fewer people are needed for operation and maintenance, thus vastly reducing operating costs and reducing safety risks.

STRATEGIC OPTIONALITY. Adopters of PI have the strategic flexibility to disrupt the competitive dynamics of their industry. By reducing feedstock costs by 90%, the operator of a PI chemical processing or manufacturing plant can use the increase in profitability to establish a cost leadership position and acquire market share or harvest the economic rents to generate capital to expand PI capacity and expand into new markets.

SAFER, CLEANER OPERATIONS. The advantage of an operational footprint only one-tenth the size of a traditional facility translates into more easily controlled environments. Importantly, efficient chemical reactions approaching laboratory conditions also result in less waste and dramatically lower emissions. Additionally, fewer required people means an improved overall safety posture.



INTENSIFICATION
REACTION CUBE

THE TID PROCESS INTENSIFICATION SOLUTION – THE CUBE

Process Intensification solutions from TID are the results of technological breakthroughs achieved in the four primary factors that impact the efficiency and speed of chemical processes. TID has harnessed these four factors via proprietary technology to provide its Intensification ZONE services that are the heart of The CUBE solution, raising chemical reaction efficiency to levels previously only seen in the lab.

The CUBE from TID has the potential to reduce chemical reaction times by 85-90% over traditional processes, based on current applications of TID's proprietary technology in the field, and based on these four factors:

KINETICS. PI chemical reactions occur in a substantially smaller area than in traditional equipment. This smaller and more controllable space allows for reaction efficiency in plants to reach previously unattainable levels typically found only in laboratory environments. The proprietary technology used in TID's solutions enhance mixing, improve mass and heat transfer, kinetics, yields and specificity.

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UTILITIES. PI employs specialized equipment that combines separate unit operations, such as reaction and separation, into a single device, which results in a more efficient, clean and economical process. TID has the rare expertise needed for Front-End Engineering Design of PI equipment to specific applications and the experience required for Engineering, Procurement and Construction of PI facilities.

CONTROLS. PI processes occur significantly faster than traditional processes, requiring advanced sensors, controls and platforms for effective and efficient operation. TID’s breakthroughs in controls facilitate real-time data acquisition, connecting on-line manufacturing data with advanced computer simulation and modeling, and enterprise-wide optimization of operations. TID’s innovations are critical to taking Process Intensification out of the realm of theory and putting it into practical application.

CATALYSTS. Given the speed of PI reactions and the heat and pressure involved, PI processes often require multifunctional catalysts having specialized composition. TID’s proprietary catalyst research and intellectual property determine the efficiency, yield, and selectivity that can be achieved in hybrid reaction and separation systems.

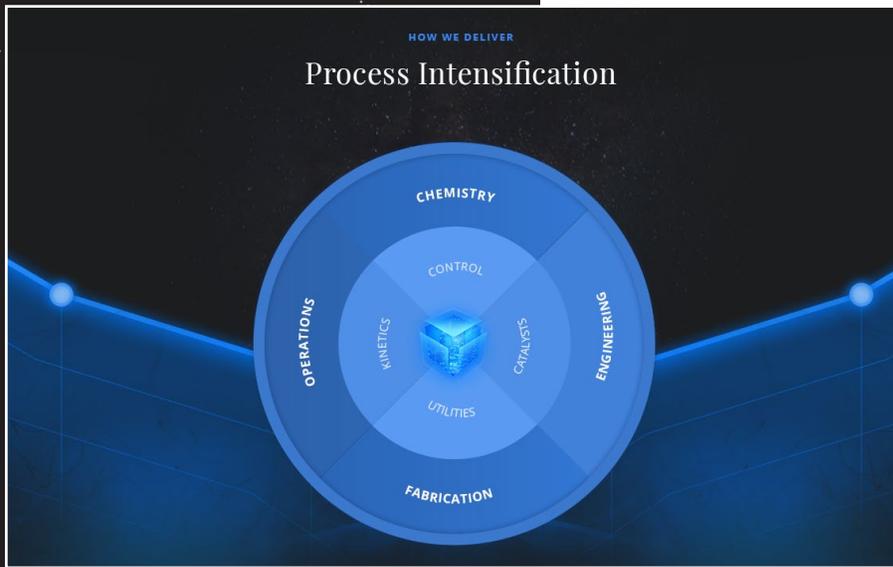
Using TID’s Process Intensification Core Technology, chemical rates of reaction increase by a factor greater than 10. This allows for an equal reduction in scale and footprint. The CUBE’s smaller size and advanced computer sensors, monitors and control, allow for similar reductions in capital and variable costs, as

well as headcount. Safety is improved, and liability is mitigated. It is the only example of a large commercial-scale platform modifiable to be a zero-emission chemical manufacturing solution available today.

APPLICATIONS

Applications for Technology Investment & Development’s patented CUBE Process Intensification solution crosscut energy-intensive industries. Some of the most promising applications include the following:

- Chemical processing
- Petroleum refining
- Natural gas liquids processing
- Plastics
- Oil and gas production
- Pharmaceuticals
- Food industries



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CONTACT

CONTACT US TODAY AT
(321) 559-2916 TO INQUIRE IF THE
CUBE PROCESS INTENSIFICATION
SOLUTION CAN BE APPLIED TO
YOUR SITUATION.

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FINANCIAL AND BUSINESS IMPACTS

The impact of The CUBE Process Intensification solution on a company's financial posture can be transformational, like the technology itself. By leveraging these advantages of The CUBE, an enterprise has the strategic optionality for pursuing various strategies, including market share acquisition, profit maximization, backward or forward integration and supply chain disruption.

CAPITAL EFFICIENCY. Because PI facilities are smaller and more efficient than traditional chemical plants, processing and production facilities and refineries, much less capital is required to design, construct and commission a CUBE Process Intensification solution from TID. For example, using the oil refinery example earlier in this paper, it would cost \$330 million to design, construct and place into service an oil refinery at prevailing material and labor costs. A PI solution having the same capacity and output volume would cost approximately \$30 million.

EFFICIENT OPERATIONS. A facility powered by The CUBE is also more efficient, requiring less energy and fewer people to operate safely. Adopters of The CUBE can expect a reduction in operating costs on the order of 17-33%, depending on the application.

FASTER TIME TO FIRST PRODUCTION. As a result of The CUBE's smaller plant sizes, the time required for construction is significantly shorter and facilities begin producing sooner than traditional plants. Instead of 61 months to build and commission an oil refinery using traditional technology a refinery powered by The CUBE technology requires only 18 months. As a result, a refinery with the same output can begin generating cash flow almost four years sooner, which has a dramatic positive impact on project economics and returns on capital.

IMPROVED SAFETY PROFILE. Smaller plant size, less complexity, more efficient chemical reactions and fewer personnel combine to create an improved health and safety profile. Using The CUBE, instead of the typical 60-person crew, a shift can be reduced to only six, highly-skilled people. In addition, the smaller plant size is easier to operate, control and maintain.

REDUCED EMISSIONS. Another benefit of dramatically improved chemical process efficiency is less byproducts and lower emissions. In most applications, The CUBE can reduce emissions by as much as 99% as compared to conventional process technology. Using The CUBE, industry can take the lead in establishing higher levels of performance and lower levels of emissions in advance of regulatory mandates.