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The future vision of the application of genetic algorithm in designing a fluidized catalytic cracking unit and chemical engineering systems -a far-reaching review.

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Abstract: Genetic algorithm and application domain of multi-objective optimization have a purposeful and definitive vision for the future. Petroleum refining industry is moving from one dynamic challenge to another. The world of challenges are absolutely drastic and far-reaching. Science, technology and petroleum refining are the basic and fundamental parameters of the growth of an economy, whether it is developed or developing. Depletion of fossil fuel resources ,energy sustainability and growth and progress of a nation are the primordial issues of our present day human civilization. Science and engineering of petroleum refining needs to be reassessed and revamped. Technological validation to the human society needs to be readdressed. Fluidized catalytic cracking is a vital and primordial issues in the entire gamut of petroleum refining. Enhancement of octane number is a feasible target. Energy sustainability and the issue of depletion of fossil fuel resources are vibrant awakening to scientific endeavour of the future. This review delineates with a deep insight into newer technologies and subsequent application of multi-objective optimization in designing a fluidized bed catalytic cracking unit. The author plunges into the basic concepts of multiobjective optimization and the application of genetic algorithm, perspectives of petroleum refining industry , doctrines of designing the riser and regenerator of FCC(fluidized catalytic cracking) and the ultimate vision for the future. The author arises to the scientific forefront the primordial issue of the design of initial portion of the riser, the intricate mass and energy balances, immense details of hydrodynamics and the future purposeful vision.
Keywords: petroleum, refining, fluidized catalytic cracking, design.

1.0 Introduction:

Petroleum refining industry is moving steadily from one visionary change to another. The challenges are wide and versatile. In a similar vein, fluidized catalytic cracking unit concept needs to reassessed and restructured. Progress in science and technology, improved vision and the road ahead are the primordial issues of the present generation engineering science. Scientific vision and scientific fortitude are the pillars of improved and definitive vision of successful optimization mathematical techniques for the future. Energy sustainability and successful sustainable development will go a long way in opening up and evolving new vistas of innovation and new doors of intuition of immense scientific imagination. In this burgeoning era of unsuccessful energy sustainability as well as environmental sustainability, evolution of new optimization techniques and non-traditional optimization vistas will open up visionary ideals intense scientific vision.

The application domain in the field of genetic algorithm has an unsurpassed vision. The definitive vision needs to be realized to the utmost with the passage of time and with turn of each decade. The evolution

of genetic algorithm and the vast application areas surely overcome wide and versatile visionary frontiers. Petroleum refining and energy sustainability in today's world have an umbilical cord whose scientific vision needs to be reassessed.

Petroleum refining industry needs to be revamped and re-envisioned. In the present age of energy sustainability , the question of depletion of fossil fuel sources needs to be vehemently addressed with immense vigour and vision. Application of genetic algorithm and revamping of petroleum refining process needs to be addressed with immense scientific vision, caution and urgency.

2.0 Vision, aim and objective of the present treatise and present scientific endeavour:

FCC or Fluidised Catalytic Cracking is moving steadily in the visionary avenue of progress. The challenges and barriers needs to be reassessed in view of the application of multi-objective optimization in the design of a FCC unit. Envisioning the optimization of the design parameters are the primordial issues. The present treatise aims at delineating the scientific endeavour and the far-reaching scientific research thrust domains. The present scientific treatise and the purposeful scientific endeavour deals with instinctive and cogent insight the doctrine of multi objective optimization principles and the application of genetic algorithm in solving critical design problems of Fluidised Catalytic Cracking Unit. Man's as well as a scientist's vision needs to be surpassed with the passage of time and with progress of human scientific endeavour. Genetic algorithm principles, application domain and the immediate visionary future stands in the midst of immense scientific understanding in this treatise.

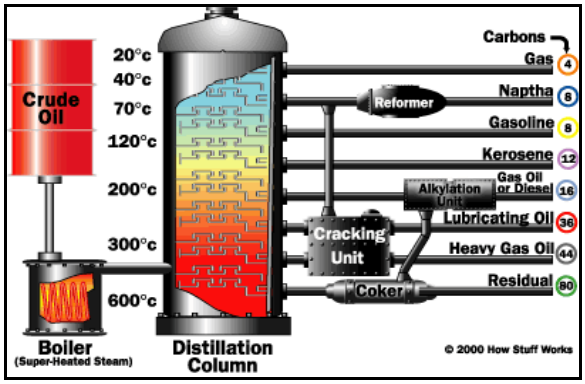

Figure 1- A crude oil distillation unit.

3.0 Multiobjective optimization, doctrine and future vision:

Multiobjective optimization and application of genetic algorithm has an unsurpassed vision for the future. Non-traditional optimization techniques are burgeoning in today's domain of optimization. Doctrine for the future is immense, versatile and inevitable. The articulation of scientific understanding for the future in the field of optimization techniques will go a long way to open up a new era of scientific vision and scientific forbearance. The future vision of chemical engineering and the importance of multi-objective optimization is frontier-surpassing and far-reaching. As petroleum refining industry enters into a new era of visionary frontiers, the world of challenges are surpassed.[1,2,3,4]

4.0 Genetic algorithm and its importance and mission:

Genetic algorithm is the next generation science and engineering frontier of multi-objective optimization. The scientific challenges needs to be readdressed and reaffirmed. The mission and goal of the application areas of genetic algorithm are surpassing many visionary frontiers. Effectiveness of the operation of fluidized catalytic cracking unit is burgeoned and objectivity readdressed. Vision, mission and aim of this treatise elucidates on the present developments and the future definitive progress of the science and engineering of genetic algorithm.

5.0 Unsurpassed vision in the domain of application of genetic algorithm and the progress of science:

Genetic algorithm is a visionary tool in the field of multi-objective optimization. Its vision and application areas are unsurpassed. Progress of science and technology and the visionary path ahead is wide and versatile. With the passage of time, scientific validation in the application areas of genetic algorithm needs to be

readdressed and reassessed. The visionary implications in the field of genetic algorithm and multi-objective optimization needs to be rejustified and reenvisioned. Man's as well as a scientist's vision is wide, versatile and ground-breaking. The unsurpassed vision and the targeted approach towards an effective application domain of genetic algorithm needs to be revalidated scientifically.[5,6]

Chemical engineering science is surging ahead tremendously with respect to optimization of chemical processes. Application , mission and clear-cut objective is imdomitable and replete with strong scientific judgement and scientific vision. Science and engineering will see a new dawn with the new and innovative ventures in the field of non-traditional optimization techniques. The world of challenges needs to be reassessed and restructured in view of the new era of evolutionary optimization and non-traditional optimization techniques.[1,2,3,4,5]

A brief view of the application of genetic algorithm in chemical engineering techniques is given below and the discussion delves deep into the hidden scientific truths of non-traditional techniques.

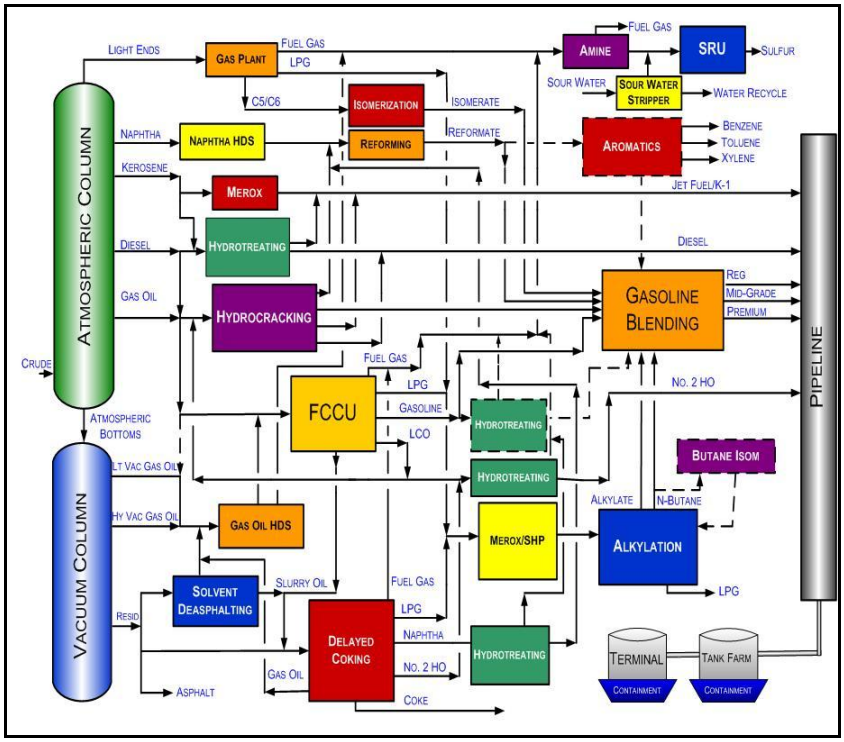

Figure2- A diagrammatic representation of a petroleum refinery.

6.0 Vision in the application areas of genetic algorithm:

Application areas of genetic algorithm are far-reaching and well proven. The domain of design of Fluidised Catalytic Cracking Unit is faced with immense challenges and visionary difficulties. The question of energy sustainability is moving steadily in the midst of immense scientific vision and scientific fortitude.

Vision of the application areas of genetic algorithm will soon surpass wide frontiers of science and engineering of petroleum refining. Lower computational time and improved efficiency of the processes will evolve a new dimension of hope and scientific justification.

7.0 Scientific endeavour, scientific vision and progress of engineering:

Scientific endeavour, scientific vision and progress of science and technology will go a long way in opening up new doors of innovation and intuition. Scientific thrust areas in the field of optimization needs a thorough revamping. Scientific vision has no parallels. Progress in engineering will usher in a new dawn of genetic algorithm and evolutionary optimization. The march and progress of science and engineering are absolutely ground breaking. Petroleum refining, energy sustainability and the future of refinery design are the primordial issues which needs to be tackled at this critical juncture of history and time.

8.0 Application, scientific thrust areas and the path ahead in the field of multi-objective optimization:

Application of genetic algorithm and the scientific thrust areas in its application to design of a petroleum refinery are wide and far-reaching. Man's as an engineer's vision should surpass wide and visionary frontiers. History of petroleum refining technology is ushering in a new era of scientific vision and an age of immense scientific understanding. The challenges need to be redrawn and restructured.

Kasat et al(2012)[7] enlarged and enhanced the domain of design of FCC unit and the application of non-traditional optimization techniques. Their study instinctively raises the issue of optimal operation of a fluidized bed catalytic cracking unit.

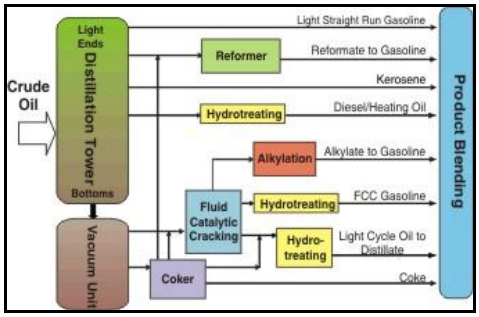

Figure 3- A diagram of a petroleum refinery and its products.

9.0 Recent advances in Fluidised Catalytic Cracking technology:

Although the Fluidised Catalytic Cracking is well established for over 60 years, the technology till today is facing numerous visionary challenges. The technologies needs to be readdressed and re-envisioned. On the reactor side, advances in feed injection, riser internals and riser termination have been proved to work holistically and synergistically to improve overall reactor performance. Earlier generation and earlier technologies of modern feed injection technology was introduced in the 1980's, using direct impact mechanisms for mechanization. This paper with cogent insight describes new generation of technology using two phase choking for atomization , which has been proved to be more energy efficient achieved by more uniform temperature profiles across the riser.

The FCC riser is known for its shortcomings of density and velocity variations. The newest riser internal technology minimizes these shortcomings and promotes and envisions ideal plug flow. The FCC is a sequential reaction process in which many desirable products are the intermediates.

10.0 Vision of futuristic technology of Fluidised Catalytic Cracking Unit:

FCC (Fluidised Catalytic Cracking) unit today is of immense and prime importance with the view of the global petroleum refining crisis. Scientific vision, scientific judgement and scientific understanding will go a long way in opening the wide doors of immense innovation in years to come. Fluidised catalytic cracking has immense barriers in the design stage and enhanced and improved future challenges. Future dimensions and future directions in FCC design needs to be revamped and reassessed. Objectivity, vision and question of energy sustainability will enhance the design clauses and improve the effective design of a FCC unit.

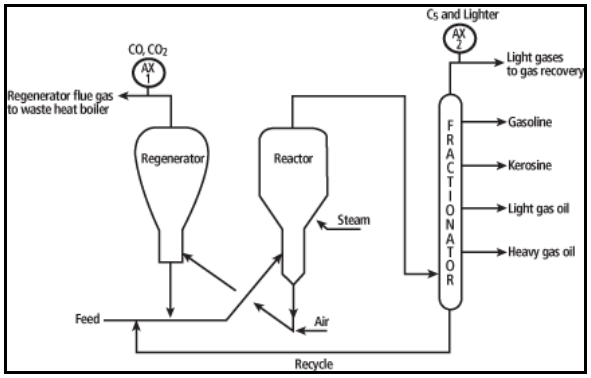

Figure 4- A diagrammatic representation of a Fluidised Catalytic Cracking Unit.

11.0 Application of genetic algorithm in chemical engineering systems:

Chemical engineering systems have a wide and versatile vision. The efficiency of multi-objective optimization will go a long way in opening up new avenues of scientific justification and scientific fortitude. Chemical engineering systems have intricate vision. The objective of application domain of genetic algorithm needs to be reassessed at the turn of each decade. Application of non-traditional optimization techniques will go a long way in evolving a new generation of scientific vision and scientific fortitude. Chemical engineering systems needs lot of resolution and needs to readdressed with respect to scientific validation in its truest sense. Genetic algorithm has a dynamic presence in the field of computational science. The vision needs to be adjudicated and re-envisioned.

Chemical engineering systems are widely and instinctively complicated. The vision and aim of a designer should be to unravel the hidden truths and the latent scientific vision and scientific understanding. Chemical engineering systems and its application are moving briskly and steadily from one visionary frontier to another. History of chemical engineering science has a purposeful and definitive vision. In such a critical juncture of history and time, chemical engineering systems needs to be revamped and re-envisioned with respect to application of optimization tools.

12.0 Application of genetic algorithm in design of a fluidized catalytic cracking unit:

Fluidised catalytic cracking unit is an integral part of petroleum refining industry. The immense importance, visionary implications and the progress of science in this domain is scientifically awe inspiring and versatile. The application of genetic algorithm in design is absolutely replete with scienctific vision and scientific steadfastness.

Application areas of genetic algorithm today stands in the midst of immense scientific vision and scientific steadfastness. Kasat et al(2012,2013)[7,8] dealt with deep insight the issues of the success of designing a FCC unit with the help of genetic algorithm and non-traditional optimization techniques. History of design of petroleum refinery units stands in a glorious foothold and visionary foundation. Multi-objective optimization of the various operating parameters leads the designer towards a visionary future of the operational success of FCC unit.

13.0 Fluidised catalytic cracking, vision for the future and definite objectives:

Vision for the future and definite objectives needs to be redefined and rejudged. The decisive factors of fluidized catalytic cracking efficiency needs a vehement and targeted revamping.

Fluidised catalytic cracking (FCC) is one of the important conversion processes in petroleum refineries. It is widely used to convert the high-boiling , high molecular weight hydrocarbon fractions of crude oils to more valuable gasoline , olefinic gases and other products.

As a crucial and critical process in petroleum refineries, fluid catalytic cracking (FCC) produces liquefied petroleum gas, gasoline , diesel and propylene from heavy distillates such as vacuum gas oils or even residues. Researchers reported that about 75% gasoline , 30% diesel and 40% propylene in China were produced by FCC upto 2007. It is of great significance and importance to optimize the design and operation of FCC processes for their huge throughputs.

14.0 Importance of fluidized catalytic cracking unit in petroleum refining:

Fluidised catalytic cracking unit in petroleum refining is a vital element of the success of this monstrous industry. The question of energy sustainability is virtually linked to the vision of petroleum refining. Petroleum refining industry is standing in the midst of deep optimism and immense visionary comprehension. The world of challenges is befitting to the immense progress of science and technology. Energy sustainability is the backbone of present day human civilization . Depletion of fossil fuel resources is of crucial and of primordial importance.

15.0 Design of riser and regenerator portion of a FCC Unit and application of genetic algorithm:

Design of the riser portion of a FCC unit is the focal point of diverse petroleum refining technology. The time limitation in the initial portion of riser unit has visionary implications. Sound design and effective methodology are the primordial issues which needs to be tackled at the utmost. The upshot of the design and

operation of a FCC unit stands on the design of the initial portion of the riser where most of the reactions and major operational challenges are envisioned. Operation, feasibility and viability of the visionary implications of petroleum refining stands on the backbone of FCC unit.

16.0 Petroleum refining industry, energy sustainability and the immediate vision for the future:

Energy sustainability and improved sustainable development of human society are the parameters of human progress in science and technology. Scientific understanding and scientific truth are the objectives and mission of human progress and holistic scientific pursuit. Scientific research endeavour should have a purpose and a definitive vision. Challenges and barriers to energy sustainability are immense as well as visionary. The immediate vision of petroleum refining industry is the revamping and reassessment of the design of a petroleum refining unit.

17.0 Scientific cognizance and applications of genetic algorithm:

Scientific cognizance and scientific sagacity will go a long way in unfolding the hidden truths of chemical engineering systems including petroleum refining. History of human civilization is a vibrant witness to the upheavals, progress and march of science and technology. Cognizance and scientific understanding has no bounds. History of application of genetic algorithm , the objectivity and immense scientific vision are the focal points in the revamping of petroleum refining in view of depletion of fossil fuel resources. The vision needs to be surpassed with the turn of each decade in the present century.

18.0 Application of genetic algorithm and reduction of computational time:

Genetic algorithm and its application areas are surpassing vast frontiers of engineering science. Kasat et al(2002,2003)[7,8] dealt incisively on the issue of reduction of computational time in designing Fluidised Catalytic Cracking Unit with the help of genetic algorithm. Frontiers of science are visionary and ever- path breaking. Genetic algorithm simplifies optimization techniques and effectively reduces computational time. A clear visionary understanding will go a long way in evolving newer optimization paradigm.

19.0 Scientific endeavour in the domain of application of multi-objective optimization in designing FCC unit:

Scientific endeavour in the truest sense should be replete with scientific vision and scientific validation. Validation of research will go a long way in devising new vistas and new windows in the long pursuit of new ventures. Scientific validation has an umbilical cord with progress of technology and inevitable scientific vision. The world of difficulties, immense scientific imagination and improved scientific thrust are the future parameters of the revamping of petroleum refining unit. The challenges and visionary barriers needs to be reassessed and re-envisioned.

Kasat et al(2002)[7] dealt with incisive insight on the application of multi-objective optimization in designing industrial Fluidised Catalytic Cracking Unit using elitist nondominated sorting genetic algorithm . They emphasized on the vision of application of non traditional optimization techniques in designing chemical engineering systems. The present study provides insights into the optimal operation of the fluidized bed catalytic cracking unit. A five-lump model is used to characterize the feed and products. The model is tuned using industrial data. The elitist non- dominated sorting genetic algorithm (NSGA-II) is used to solve a three objective function optimization problem. The objective functions used are maximization of gasoline yields, minimization of air flow rate and minimization of the percent CO in the flue gas using a fixed feed flow rate. The decision variables and several important state variables corresponding to optimal conditions of operations are obtained.

Kasat et al(2003)[8] delineated with cogent insight on multi-objective optimization of an industrial fluidized bed catalytic cracking unit (FCCU) using genetic algorithm (GA) with the jumping genes operator. The multi-objective optimization of industrial operations using genetic algorithm and its variants , often requires inordinately large amounts of computational time. Any adaptation to speed up the solution procedure is desirable. An adaptation is developed in this study that is inspired and emulated from natural genetics.It is based on jumping genes(JG; transposons). The binary coded elitist non-dominated sorting genetic algorithm (NSGA-II) is adapted and the new code , NSGA-II , JG is used to obtain solutions for the multi-objective optimization of fluidized catalytic cracking unit(FCCU). The CPU time required for this problem is found to

reduce five-fold when NSGA-II-JG is used as compared to when NSGA-II was used. The vision of this study is to devise new algorithm to improve upon the performance of multi-objective optimization of a FCCU unit.

The fluidized bed cracking unit is an important unit in refineries. Several studies have been reported in scientific literature dealing with their modeling and simulation , kinetics , multiplicity of steady states , chaotic behavior , on-line optimization and control. Extensive research on the fluidized bed catalytic cracking is dealt in literature.

Ramteke et al(2011)[9] dealt lucidly on the kinetic modeling and reactor simulation and optimization of industrially important polymerization processes. This mini-review summarizes a small sampling of literature in polymerization reaction engineering over the last four decades. The concepts in this area are now being applied in a variety of specialized domains eg. Polymerization in the nanoscale , design and control of the nanostructure and rapid optimal switch over of grades being manufactured , molecular simulation and computational fluid dynamics.

Chen et al(2013)[10] evaluated the role of intraparticle mass and heat transfers in a commercial FCC riser .It involved meso-scale study. The paper provides new insights into the fundamental mechanism of catalytic cracking from the meso-scale viewpoint. Intra particle mass and heat transfers were studied under fluid catalytic cracking (FCC)reaction conditions.

Zhang et al (2013)[11] delineated FCC concept on the modeling of fluid catalytic cracking risers with special pseudo-components. Special pseudo components (SPCs) are proposed to be the compositional entities for characterizing the complicated mixtures of stock and product oils involved in fluid catalytic cracking risers. SPCs have invariant and definite physiochemical properties and are defined in pairs of light and heavy oil cuts of narrow boiling range. A steady state model for a prototype riser with a side feed stream is formulated where material and heat balance is strictly observed and the hydraulic behavior is considered.

20.0 Mission and immediate objectives in design of FCC Unit:

Mission and immediate objectives in design of FCC unit needs to be reassessed and revamped. History of human civilization today is moving through immense crisis and indomitable visionary ventures. A FCC unit is of primordial importance and a far-reaching tool in successful petroleum refining. The challenges and ventures needs to be reassessed and re-envisioned. The truest vision of FCC procedure will be realized if new optimization tools such as genetic algorithm and multi-objective optimization opens up new doors of innovation and successful intutuion.

21.0 Application of genetic algorithm in multi-objective optimization of chemical engineering systems:

Multi-objective optimization has immense visionary domains which needs to be tackled vehemently and intensely. The drastic challenges are far-reaching, wide and ground-breaking. Advancement of science and technology in chemical engineering and petroleum engineering are visionary focal points of tomorrow. In the critical juncture of the future of petroleum engineering and depletion of fossil fuel sources, the application of optimization tools and effective computational tools will be the torchbearer to the future vision of human mankind. Human civilization is at a definite stake with the progress of science and engineering. The world of drastic and definitive challenges are befitting to the path towards progress.

Any real world concept in optimization involves several objectives. Chemical or petroleum engineering is no exception. Chemical processes , such as distillation , refinery operations, polymerization etc involve a lot of parameters which are to be set for achieving certain properties in the final product. Often such a process is modeled using a number of differential equations and algebraic equations describing the system. Optimization is also used for tuning of first-principle models using experiment/ industrial data. The main challenges and barriers in a chemical optimization problem are the existence of time-variant decision variables , multiple objectives and uncertainities and challenges in the model accuracy.

In the early years of scientific pursuit, the several objectives were scalarized by using their weighted average as a single objective function and optimizing it. Unfortunately , these values of these weighting factors could not be assigned without controversy. The e-constraint method was probably the first approach used to solve multi-objective problems. In this technique, any one objective was selected for optimization, while the remaining objective functions were converted to equality constraints. This method was inefficient computationally, particularly since it involved the solution of several single-objective , highly constrained

problems. In the last decade , several multi-objective adaptations of the stochastic , population based genetic algorithm(GA) have been developed for solution of multi-objective optimization with efficiency.

Two popular adaptations of the simple GA (SGA for single objective problem) are the non-dominated sorting genetic algorithms- NSGA-I and the elitist NSGA-II.

$$\text{Min } \mathbf{I}(\mathbf{x}) \equiv [\, I_1(\mathbf{x}),\, I_2(\mathbf{x})] \qquad \text{(a)}$$

subject to (s.t.):

Model equations; (b)

$$g_j(\mathbf{x}) \le 0, \quad j = 1, 2, \ldots, J; \qquad \text{(c)}$$

$$h_k(\mathbf{x}) = 0, \quad k = 1, 2, \ldots, K; \qquad \text{(d)}$$

(1)

A two objective function minimization problem can be represented mathematically as above

Equation (1) . In Equation (1) x represents a p-dimensional set(vector) of p design or decision variables . One needs to obtain the optimal values of x which will minimize the two individual objective functions I_1 and I_2.

22.0 Vision behind genetic algorithm in chemical engineering applications:

Scientific vision, scientific steadfastness and the vast knowledge of scientific understanding are the visionary primordial issues of tomorrow. The path towards progress is inspiring and absolutely far-reaching. Chemical engineering and its applications are surpassing visionary frontiers in today's world. Energy sustainability stands today in the midst of hope, optimism, concern and scientific vision. A scientist's as well as an engineer's vision needs to be reshaped with the serious concern of depletion of fossil fuel resources. Modelling of the chemical engineering systems today stands in the juncture of scientific optimism and scientific fortitude. The coherent world of chemical engineering systems has merged with the world of concerning petroleum science and engineering.

Genetic algorithms are also applied to solve chemical engineering problems with scientific vision. Holena(2008)[12] did a detailed study on the application of genetic algorithms for optimization of catalysts in chemical engineering. The treatise addresses key issues pertaining to the evolutionary approach to the search of optimal catalysts in chemical engineering.[12] The scientific scenario is such that there are insufficient dealings in existing implementations of genetic algorithms with mixed optimization , which plays a crucial role in catalysts and on the other hand on the narrow scope of genetic algorithms developed specifically for searching optimal catalysts.[12] The paper proposes an approach to constrained mixed optimization based on formulating a separate linearly constrained continuous optimization task. This effort reveals the immense visionary potential of application of genetic algorithm in optimization of chemical engineering systems.[12] Challenges , difficulties and unsurpassed frontiers needs to be overcome at its intense utmost in the applications of genetic algorithm.

23.0 Scientific cognizance, scientific vision and the progress of genetic algorithm in path ahead:

The vision of tomorrow will go a long way in opening up new vistas of progress and effective scientific cognizance in the enhancement of knowledge and doctrine in the application of genetic algorithm in chemical engineering and petroleum engineering. In today's world of human progress, future of petroleum engineering is at deep stake. Depletion of fossil fuel resources has plunged human civilization to an intense concern and a deep comprehension. Optimization and other mathematical tools has ushered in a new scientific approach and a newer avenue. Man's as well as a scientist's vision are opening up new vistas and new avenues of intense concern in years to come.

24.0 Challenges, difficulties and barriers in the application areas of genetic algorithm:

Challenges, obstacles and visionary barriers are the focal points in the scientific endeavour in application of genetic algorithm. The vision of scientific validation needs to be addressed at the utmost. Genetic algorithm applications in multi-objective optimization today stands in the midst of immense scientific vision and vast scientific adjudication. Challenges, difficulties and immense hurdles are urging the scientific community to target towards newer visionary targets. Petroleum engineering is moving from one drastic challenge over another. In such a critical juncture of human vision and scientific pursuit, challenges in application of genetic algorithm are ushering a new era in Chemical and petroleum engineering.

25.0 Future directions, future perspectives and the progress of engineering ahead:

Future directions and future perspectives in the application of genetic algorithm in the design of a FCC unit are visionary and far-reaching. Computational time is a primordial issue in the successful application of genetic algorithm in design of a chemical engineering system. The challenge and the success in design needs to be readdressed and re-envisioned with the progress of engineering.

26.0 Future vision and future flow of thoughts:

Future vision in the field of genetic algorithm and application of multi-objective optimization has to be targeted towards a strong scientific understanding and effective scientific steadfastness. History of science and technology and progress of human mankind today stands in the midst of immense pessimism and indomitable vision. The question of energy sustainability is at stake and in the midst of immense peril. So the world needs to be a witness to immense challenges and definitive vision. The purposeful vision of today is the vision of tomorrow. Opening new frontiers in energy sustainability will be the target of tomorrow.

Man's as well as a scientist's vision is wide, far-reaching and immensely versatile. Challenges in application of optimization techniques are visionary and have crossed vast scientific frontiers. Future directions, future frontiers and future dimensions are all targeted towards effectiveness and viability of the application domain of genetic algorithm.

Future destiny in the field of application of genetic algorithm in chemical engineering systems is path-breaking and visionary. The challenge lies in the low computational time. A scientist's vision is emboldened and enhanced with the progress of history of petroleum refining and time. Petroleum refining and chemical engineering systems needs to be re-envisioned and restructured with the concern of effectiveness and efficiency of the process. The challenges needs to be redrafted with the future flow of thoughts. Fluidised catalytic cracking needs to be revamped with the progress of the question of environmental and energy sustainability. With such a critical juncture, man's progress needs to be revisited and revamped.

27.0 Conclusion:

Fluidised catalytic cracking today stands as a major designer's backbone amongst various units of a petroleum refinery. The world of challenges and visionary barriers needs to be surpassed. Petroleum refining and energy sustainability have an unsevered umbilical cord. Non traditional multi-objective optimization techniques are the visionary challenges of the future of FCC design. The ultimate and versatile vision of tomorrow will open up new doors of innovation and new vistas of scientific endeavour in years to come in the domain of fluidized catalytic cracking design.

28.0 Acknowledgement:

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