



**ENVIRONMENTAL ENGINEERING SCIENCE, CHEMICAL ENGINEERING
AND A VISIONARY FUTURE - A FAR-REACHING – REVIEW.**

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ABSTRACT

The science and technology of environmental engineering and chemical engineering is moving forward by leaps and bounds. Scientific vision, scientific understanding and the immense challenges are the hallmarks of newer scientific endeavour. History of science and technology and history of scientific progress is witnessing newer future direction and innovative directions. In today's world of cut-throat competition and scientific urge to excel, challenges and future trends needs to be reshaped. History of human civilization is ushering in a new beginning. Global warming, global water shortage and industrial pollution has propelled scientific endeavour to move towards visionary direction. Scientific tools and environmental engineering techniques has re-envisioned the entire scenario of industrial pollution control and application of chemical engineering. History of science is veritably ushering in a new era. The author gleans and gives deep insight to the recent trends of chemical engineering and application of environmental engineering techniques to tackle global industrial pollution, global water shortage and the future of energy and environmental sustainability. The success of this treatise is the invaluable research pursuit in the field of environmental engineering science and its wide world of water treatment techniques. Energy and environmental sustainability is slowly and steadfastly moving towards a new realm of scientific vision and scientific fortitude. Chemical engineering and environmental engineering science in today's world have an unsevered umbilical cord. Challenge, vision and urge to excel will lead a long way in opening new doors of innovation in decades and years to come.

KEYWORDS: environment, energy, sustainability, challenge, vision, chemical engineering.



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1.0 INTRODUCTION

Scientific vision and scientific understanding are moving our human civilization towards a newer realm. The world of challenges, scientific difficulties and inimitable concerns are ushering in a newer era in the field of environmental engineering science and chemical engineering. In today's scientific world, environmental engineering science and chemical engineering have an unsevered umbilical cord. History of human civilization today is at deep distress. Man's vision as well as a scientist's progress is emboldened with the passage of time and history. Scientific innovation in environmental engineering science is ushering in new thoughts and new vistas of scientific instincts. Earth and its environment is at a deep distressful condition. Environmental catastrophes are disastrously debilitating the progress of human civilization. At this crucial juncture, history needs to be re-envisioned and stringent environmental restrictions needs to be enforced. Emancipation of science is at its zenith and environmental engineering research pursuit is surpassing wide and visionary frontiers. Advancements of scientific cognizance, the world of innovative technologies and the future scientific endeavour are ushering in a new era of emboldened scientific vision in years to come^{1,2,3,4}

2.0 Purpose and aim of the present study

The world of engineering science is moving drastically towards one visionary frontier over another. Challenges, difficulties and vision are the hallmarks of the future of environmental engineering and chemical engineering. History of science is moving towards a newer vision and immense truth and understanding. The author delves deep into the application domain of environmental engineering with immense cogent insight. The emancipation of science is discussed in details with the objective of immense scientific vision. Environmental regulations, stringent restrictions and deep introspection has propelled scientific endeavour to usher in a new era of environmental engineering techniques and a new dawn of visionary chemical engineering science.

Process engineering is moving towards a newer revolutionary decade. The author discusses with deep far-sightedness the visionary domain of the application of process engineering is realizing environmental regulations. Environmental catastrophes, deep disasters and scientific understanding are the pallbearers to a new generation of process engineering and its vision. The author plunges into the immense scientific understanding and scientific truth behind process engineering and environmental engineering science^{1,2}

3.0 New avenues in Chemical Engineering and Environmental Engineering science

New avenues in Chemical Engineering and Environmental Engineering Science are visionary and far-reaching. Scientific research pursuit and the wide vistas of science will open up new windows of innovation and instinct in years to come. Global water crisis today stands in the midst of immense distress and pessimism. History of science is revisiting itself with every step of human life. Redefinition of technology, mankind's vision and civilisation's prowess all will lead a long way in opening up new dimensions of research endeavour. Human mankind is moving towards a new future direction and an innovative future dimension. Future trends in scientific endeavour is veritably groundbreaking and far-reaching. The challenge lies in the application domain of engineering science. Man's vision as well as a scientist's prowess is gearing up for a new dawn of human civilization.^{5,6,7} New innovations and new avenues in engineering science are vast and large. The target and vision of engineering science should be towards acquiring and disseminating greater knowledge in the provision of basic human needs. The vision of human mankind in today's present day human civilization should be concentrated towards greater emancipation of science and its application to human society. Technology needs to be re-envisioned at every step of human progress in today's world. New avenues and new innovations are burgeoning in today's world of engineering science.

Advancements of science, technological progress and the immense urge and vision to excel will lead a long way and usher in a new era of environmental sustainability. Successful sustainable development is the motto of the future of human scientific endeavour. The world of immense scientific struggle, the question of scientific research validation and the wide path of progress are the torchbearers towards a new generation of scientific vision. Scientific validation is veritably necessary to the future of human progress in science. Human civilisation's prowess is ushering in a new era of scientific fortitude with the advancement of engineering science.

4.0 Advancement of science and technology, the vision ahead and scientific understanding

Today's world is a world of technology and the march of scientific research pursuit. The progress of science and forays in global water technology are the visionary paths towards scientific glory. Technology in today's world is moving very fast steadily and steadfastly. The need for scientific vision is of utmost importance. Scientific validation, human scientific progress and the surge ahead are the visionary targets for the future of path towards scientific glory. Advancement of science and technology is definitive and inspiring. The future of science needs to be re-envisioned and revisited at every step of history and time. Challenges, barriers and scientific vision are the pallbearers towards a newer dimension of scientific grit and determination. Science and technology is moving towards a newer degree of immense vision and fortitude. In a similar vein, environmental engineering and chemical engineering is also moving towards a newer world of drastic vision. Challenges and difficulties are befitting to the progress of human civilization. Today's visionary target should be towards greater scientific validation and scientific forbearance and a greater emancipation of environmental sustainability. The world of challenge is moving briskly and drastically towards a newer dimension. Environmental engineering science, progress in chemical engineering and purposeful scientific

vision will all lead a long way in surpassing wide and vast visionary frontiers.^{8,9,10}

5.0 Global water crisis, sustainability and the pursuit of science

Global water crisis and the future of environmental sustainability is at great distress with the progress of human civilization. History of science needs to be revisited vehemently and intensely at the utmost with human progress. Pursuit of science in today's world is at a deep distress. Deep comprehension, instinctive introspection and the march of science are the ultimate parameters of progress of human civilization. In today's world of science, technology, engineering and vision should move parallel and with immense vigour to overcome vast frontiers. Global ground water crisis stands in this decade amidst immense pessimism and disaster. History of science and technology needs to be restructured and re-envisioned with every step of human progress. Environmental sustainability, the alleviation of global water crisis and progress of science will all lead a long way in greater and glorious emancipation of pursuit of science towards human needs. Poverty eradication, gender equality, affordable and reliable energy accessible to all, inclusive, safe, resilient cities and sustainable water management and waste management are the overarching and over-riding goals of the future of Sustainable Development Goals that the United Nations General Assembly is expected to come up within 2015. The pursuit and emancipation of science and engineering is heading for a new beginning.

6.0 Arsenic groundwater remediation and future of human life

Arsenic groundwater contamination and future of human citizens is causing havoc in developed as well as developing economies. Future of human life and human endeavour is at great distress. The world of challenges in green engineering is in deep catastrophe. Scientific validation and scientific vision needs to be restructured with every step of target towards arsenic groundwater remediation. Man's progress and civilisation's prowess are moving towards a newer realm and a newer

visionary frontier. A concerted effort of the civil society and instinctive scientific validation will go a long way in uncovering the causes of the largest human disaster of arsenic groundwater contamination. Future of human life will only be emboldened if true scientific vision is realized. Arsenic and heavy metal contamination of groundwater is an inimitable disaster to the human disaster. The world of challenges, the answers to environmental sustainability and the path towards progress will all lead a long way in evolving new dimensions in future scientific endeavour.^{11,12,13,14,15}

7.0 Arsenic groundwater pollution and its immediate and grave concern

Immediate and grave concern is today ushering in new dimensions in arsenic groundwater remediation. Scientific realm, intense vision and future directions are the hallmarks of futuristic scientific endeavour. The aim and the goal of the scientific rigour should be towards definitive vision and veritable results. Scientific fortitude is in the new generation of hope and scientific grit. The world of challenges in today's human civilization are arduous and difficult. Arsenic groundwater contamination is causing inimitable and disastrous havoc to the human civilization. Future of human society is in veritable distress. The world of scientific emancipation is crumbling like a house of cards. History needs to be redefined at every step of human progress. At this crucial juxtaposition of history and time, the vision of environmental engineering techniques needs to be revisited and reshaped. Water technology is at its veritable crisis. The global water crisis and its challenges needs to be revisited at every step of human history.¹⁵

8.0 Heavy metal remediation in groundwater and its vision

Heavy metal remediation is the next grave concern of environmental catastrophe and is today facing immense challenges. Heavy metal is a collective terminology, which applies to the group of metals and metalloids with atomic density greater than 4000 kg m^{-3} , or 5 times more than water and they are natural components of the earth's crust. Although some of them act as essential micronutrients for living

beings, at higher concentrations they can lead to severe poisoning. The most toxic form of these metals in their ionic species are the most stable oxidation states eg., Cd^{2+} , Pb^{2+} , Hg^{2+} , Ag^{+} and As^{3+} in which they react with body's biomolecules to form extremely stable biotoxic compounds which are difficult to dissociate. In the surrounding environment, the heavy metals are generally more persistent than organic contaminants such as pesticides or petroleum byproducts.¹⁵ They can become mobile in soils depending on soil pH and their speciation. So a fraction of the total mass can leach to aquifer or can become bioavailable to living organisms. Grave concerns, inimitable disasters and the world of barriers and difficulties have urged the scientific domain and scientific generation to devise new and innovative technologies. Heavy metal remediation of groundwater is of utmost in many countries of the developed and developing world. Scientific vision, scientific doctrine and the invention of innovative environmental engineering techniques will go a long and visionary way in the veritable emancipation of science and engineering.

9.0 Remediation technologies and future directions of chemical engineering and environmental engineering

Remediation technologies of heavy metal contamination of groundwater and drinking water are of utmost importance to the future perspectives of environmental engineering science. Advancement of science, provision of basic human needs and the urge to excel in scientific research pursuit are the forerunners and pallbearers of newer scientific realm. Several technologies exist for the remediation of heavy metals contaminated groundwater and soil and they have definite outcomes such as :
1) complete or substantial destruction/degradation of pollutants, 2) extraction of pollutants for further treatment and disposal, 3) stabilization of pollutants in forms less mobile or toxic, 4) separation of non-contaminated materials and their recycling from polluted materials that require further treatment, 5) containment of the polluted material to restrict exposure of the wider and surrounding environment.¹⁵ Future trends and future challenges in environmental are vast, versatile

and visionary. Science is moving fast by leaps and bounds. Emancipation of engineering science is the order of the day. The treatment technologies can be classified into the following classes: 1) Chemical treatment technologies, 2) Biological/ biochemical/ Biosorptive treatment technologies, 3) Physico-Chemical treatment technologies.¹⁵ The vision and goal of today's chemical engineering and environmental engineering should be targeted towards zero-discharge norms, clean drinking water paradigm and the greater emancipation of successful environmental sustainability.¹⁵

10.0 Successful sustainability and provision of basic human needs

Successful sustainability is the need of the hour. Present day human civilization is moving forward with inimitable crisis. The question of provision of basic human needs is challenging as also of utmost importance. Drinking water treatment is inarguably the redefined vision of the present decade. Arsenic groundwater contamination, industrial wastewater treatment and the wide world of environmental engineering science are the pallbearers of a new generation of scientific endeavour and intense scientific rigour. Successful sustainability can only be realized with glory and effectively when a concerted urge from the civil society and mankind comes into shape. Chemical engineering science is witnessing a world of effective and drastic challenges. Scientific validation, the history and emancipation of science and the wide avenue of progress will surely usher in a new age of chemical engineering science. Environmental engineering paradigm is moving towards a new visionary frontier. Scientific imagination, scientific vigour and scientific vision are the coinwords of today's human endeavour. In such a critical position, provision of basic human needs is of utmost importance. In today's world, history of human civilization is making definite turns and undergoing drastic challenges. The question of environmental and energy sustainability is of immense and visible importance with the progress of human history. The windows of innovation are wide open with the passage of time and the wide awakening of human history.^{15,16,17}

11.0 Sustainable development and progress of human civilization

Progress of human civilization in today's world depends on successful sustainable development. Environmental and energy sustainability is gearing up for newer challenges and drastic future. Man's vision as well as a scientist's prowess is emboldened with the innovation of newer technologies and newer visionary scientific techniques. Environmental engineering techniques is moving towards a newer scientific realm and a newer scientific generation. Sustainable development is a veritable crisis in today's world. Mankind's history is witnessing a newer scientific life. History of human civilization is ushering in a new era. The future realm of chemical engineering and environmental engineering science is veritably groundbreaking. History of civilization is moving towards definite direction and definite and drastic challenges. Man's vision, progress of science and scientific emancipation of engineering are the pallbearers of future human society. At today's critical juncture of human history and human society, provision of basic human needs derides all other vision. Mankind should in the direction of energy and environmental sustainability.^{15,16}

12.0 Energy and environmental sustainability

Energy and environmental sustainability is the vision of tomorrow. Global water shortage, sound and successful sustainability and the surge of science are the torchbearers of tomorrow. History of civilization is moving in a definite and correct direction with the passage of time. The question of sustainability is a primordial issue of tomorrow's human endeavour. Human scientific endeavour needs to be rejustified and restructured at every step of life. The world of challenges needs to usher in a veritably new beginning. Energy and environmental sustainability is moving towards a next generation science and engineering realm. Grave concerns of sustainability, environmental regulations and the futuristic vision of environmental engineering science will all lead towards a new dimension of scientific hope and scientific determination.^{15,16}

13.0 Future of environmental sustainability and alleviation of global water crisis

Future of environmental sustainability is in the road towards scientific vision and scientific innovation. Global water crisis, provision of basic needs and sustainable infrastructural development are in the path towards definitive progress. Global water crisis, progress of science and the redefining path of environmental engineering techniques all lead a long way in re-envisioning the concept of engineering science. Engineering innovations and progress of technology are the present day parameters of human growth and successful human endeavour. The strong vision of science and urge to excel is ushering in a new era of energy and environmental sustainability. Water technology, industrial wastewater treatment and groundwater remediation today stands in the midst of immense introspection and vision. Provision of clean drinking water is a parameter of growth of present day human civilization. History of science is ushering in a new beginning and a new innovative era. Man's progress, human scientific endeavour and the future path of vision are all the parameters of a new dawn of human civilization.

14.0 Future drastic steps to ensure sustainable development

Future drastic steps, the vision and urge to excel are the pallbearers of a new scientific generation. Process engineering and chemical engineering science is moving towards a newer realm and a newer visionary era. Science and technology are witnessing a new surge in economic and societal domain. In today's world, drastic measures and innovative steps are the torchbearers of newer scientific vision and innovative scientific understanding. Emancipation and vision of science is witnessing a new beginning. Challenges, fortitude and immense resilience marks the beginning of each decade in the pursuit of science. Science and technology is moving towards a newer vision and a newer realm. At such a critical and crucial juncture of human progress, scientific validation, scientific vision and immense optimism are the hallmarks towards new endeavour and innovative pursuit.

15.0 Today's chemical engineering and environmental engineering science and its future scientific endeavour

Today's chemical engineering and environmental science should be targeted towards sustainability and the holistic realm of provision of basic human needs. In such a situation, global water crisis and environmental pollution control are of utmost importance. Emancipation of science and engineering can only be realized if there are concerted effort towards provision of basic human needs along the path of progress. Man's vision, mankind's prowess and civilisation's progress all depend on the parameters of civilisation's growth such as alleviating global water shortage. Developmental parameters, progress of chemical engineering and environmental engineering and the path towards progress are the hallmarks of a new generation of scientific domain and a new realm of science. Sustainable infrastructural development is the torchbearer towards the path of human progress. Today's chemical engineering and environmental engineering endeavour is moving towards newer scientific truth and innovative scientific vision. Advancements of science and technology needs to be rebuilt in every step of human progress. Science, engineering and technology is moving towards a newer visionary direction. Scientific progress, human scientific endeavour and the path towards future are the pallbearers towards a new generation of scientific realm, scientific grit and scientific fortitude. The world is moving towards a difficult crisis in provision of basic needs over the decades. The vision of chemical engineering and environmental engineering should be in the direction of more application and scientific truth.

16.0 Innovations and new developments in chemical engineering

Innovations and new developments are the pallbearers towards a newer vision of tomorrow's world. Chemical Engineering in today's world is ushering in a new dawn of science and engineering. History of science, progress of civilization and the struggle towards scientific endeavour all will go a long way in the ushering in a visionary world of engineering

science. Developments and future trends in chemical engineering should be targeted towards green engineering and visionary science. The world of engineering itself is moving through drastic challenges. Chemical engineering in the similar vein is witnessing a new era in process design, novel separation processes and green chemistry. Membrane science is in the verge of a new scientific regeneration. Novel separation processes and advanced oxidation techniques are changing the process engineering scenario of technology.

17.0 New trends in application of environmental engineering techniques:

Environmental engineering techniques are shaping and re-envisioning the domain of environmental sustainability. Progress of human civilization and march of science are the parameters of a nation's growth. Advanced oxidation techniques, chemical oxidation procedures, novel separation procedures and the wide gamut of non traditional environmental engineering techniques are opening up windows of innovation and doors of far-sightedness in years to come. New trends and future dimensions of environmental engineering techniques are restructuring the world of environmental as well as energy sustainability. History of science and technology is ushering in a new beginning. The visionary message towards the future is the application domain of both chemical engineering and environmental engineering. Scientific validation and scientific vision of chemical as well as environmental engineering needs to be reshaped with the passage of time and drastic challenges.

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18.0 CONCLUSION

History of human civilization is moving towards a new and definite direction. Scientific vision, scientific truth and deep scientific understanding are the torchbearers towards a new generation of scientific fortitude and deep introspection. Environmental catastrophes, disasters and scientific barriers are at its most in our life today. Stringent regulations and collective effort from civil society are the necessary targets of successful environmental sustainability. Successful sustainable development needs a thorough revamping and re-envisioning. Man's vision, mankind's prowess and civilisation's progress will all lead a long way in redefining environmental engineering and process engineering history. The challenge needs to be revisited at every step of history and time. Human civilisation's prowess needs to be reshaped and rebuilt with the progress of history. Engineering science is moving towards a visionary direction in the present century. In a similar vein, chemical engineering and environmental engineering science is surpassing wide and vast frontiers.

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