RESEARCH MANAGEMENT CENTRE
FUNDAMENTAL RESEARCH PROJECT PROPOSAL

(This proposal must be typewritten and sent to RMC in softcopy and hardcopy)

1.0	**INFORMATION OF PROJECT LEADER**					**Previous Project(s) - To be filled in by Project Leader**	
1.1	**NAME**	ZAHARAH IBRAHIM				**Vote No.**	**Status (Active/Close)**
1.2	**UTM I/D NO**	**2598**	**I/C NO (NEW)**	580513-08-5040			
1.3	**POSITION (Circle Position)**						
	1. Professor	2. Associate Professor	3. Lecturer	4. Others		**Research Management Centre (For official use only)**	
1.4	**DEPARTMENT/FACULTY**	**BIOLOGY/ SCIENCE**				Vote No:	
1.5	**TYPE OF SERVICE (Circle type of service)**	1. Permanent	2. Contract			Updated in RADIS by:	
1.6	**OFFICE TEL. NO.**	07-5534122				Approved Allocation (RM)	
1.7	**HANDPHONE NO.**	019-7897226				RMC comments:	
1.8	**OFFICE FAX NO.**	07-5566162					
1.9	**E-MAIL**	zaharah@bio.fs.utm.my				Name : Date :	

2.0	**DETAILS OF RESEARCH**
2.1	**AREA OF RESEARCH (CIRCLE ONE AREA ONLY)** 1. SCIENCES 2. MANAGEMENT SCIENCE 3. SCIENCE AND TECHNOLOGY (ICT) 4. SCIENCE AND TECHNOLOGY (ENGINEERING)
2.2	**PLEASE SPECIFY FIELD OF RESEARCH (CIRCLE ONE FIELD ONLY):** **SCIENCES** 1. Biology 2. Physics 3. Chemistry 4. Mathematics **MANAGEMENT SCIENCE** 1. Education 2. Built and Environment 3. Human and Environment 4. Management and Economics **SCIENCE AND TECHNOLOGY (ENGINEERING)** 1. Mechanical 2. Civil 3. Electrical 4. Chemical **SCIENCE AND TECHNOLOGY (ICT)** 1. Software 2. Hardware 3. Theoretical Computer Science 4. Comp. Systems 5. Communications

2.3	**DURATION**	**2 YEARS**	From	JUNE 2006	To	JUNE 2007

2.4 OTHER RESEARCHERS

No.	Name	Post/Designation	UTM ID No.	New I/C No.	Faculty
1.	ASSOC PROF DR ABU BAKAR BABA	ASSOC.PROF	795	470519-04-5149	SCIENCE
2.	DR. ZAITON ABD MAJID	LECTURER	5756	621201-10-6808	SCIENCE
3.	DR. ADIBAH YAHYA	LECTURER	6976	710823-01-5016	SCIENCE
4.	AMIR AZHAR AKBAR	RESEARCHER		821125-07-5179	SCIENCE
5.	NADIRAH ISMAIL	RESEARCHER		830526-14-5240	SCIENCE

2.5 **RESEARCH PROJECTS THAT ARE COMPLETED/ONGOING BY PROJECT LEADER IN THE LAST 3 YEARS. PROVIDE TITLE OF RESEARCH, YEAR COMMENCED AND YEAR ENDED**

No.	Title of Research	Year of Commencement	Year Ended
1.	Microbial physiology of Biofilms application in the bioremediation of industrial wastewater (IRPA)	2004	2006
2.	Production of microbial surfactant from the treatment of wastewater effluent from petroleum related industries	2002	2005
3.	a) Potential application of biofilter in wastewater treatment b) Development of bioparticle and biorock and its application in bioremediation of wastewater	2002	On-going

2.6 **TITLE OF RESEARCH PROJECT**

Characterization of Bioparticle for Wastewater Treatment

2.7 **JUSTIFICATIONS OF THE RESEARCH PROPOSALS IN TERMS OF FUNDAMENTAL RESEARCH**

Bioparticles have shown enhanced effects on treatment of industrial wastewater such as domestic wastewater, textile wastewater and petroleum wastewater and mixed wastewater. Recent development of bioparticles incorporating natural, economical filtering media and microorganisms has lead to practical application of biofilter system in terms of maintenance and sustaining growth of useful microbes that able to degrade & detoxify pollutants.

Industries that may incorporate biofilter/ bioparticles to complement their existing treatment system so as to enhance removal up to 80-90% before discharging their wastewater into nearest storm water drain or river.

2.8 **RESEARCH BACKGROUND (INCLUDING LITERATURE AND HYPOTHESIS):**

Bioparticles are considered a green technology that is environmentally friendly, natural and offers a more economical method for wastewater treatment. In principle, bioparticle comprise of natural media such as zeolite, slaked lime, commercial light weight material and activated carbon immobilized with consortium of beneficial microorganisms (BF) from Biology Department which have roles in wastewater treatment. Natural zeolite has the capability to remove ammonia from wastewater besides being able to adsorp organics. Activated carbon being applied to the actual wastewater stream to adsorb color and xenobiotic pollutants. the granular media plays a very important role in maintaining a high number/ population of active biomass and a variety of microbial populations. A bench –pilot scale experiment will be conducted to evaluate bioparticle ability in treating industrial wastewater. Water quality parameters are measured to determine the efficiency of bioparticles in wastewater treatment

2.9 **OBJECTIVE(S):**

1. To determine degradation mechanisms of microorganisms that able to degrade dyes, xenobiotics and aromatic hydrocarbons
2. To study physical properties of composite components such as zeolite, light weight aggregate and activated carbon
3. To optimise mix ratio design of composite components and microorganisms

2.10	**METHODOLOGY:** **1. Description of Methodology:** Bioparticles comprise of composite materials such as natural zeolite, processed activated carbon, synthetic light aggregates, slaked lime (binder) and specialized microorganisms which will be infused or grown as biofilm before it can be used for wastewater treatment. Hence it is important to determine fundamental properties of composite materialincorporated ie. Their ability to adsorp anions (nitrates, ammonium, sulphate, phosphate) organics (synthetic dye, aromatic hydrocarbon, aliphatic hydrocarbon) using kinetic and batch equilibrium batch sorption studies. Specialized microorganisms were studied to determine the mechanisms of degradation of reactive dyes, aromatic hydrocarbon and oil geraders). The microbes will be infused with composite materials or grown as biofilm , observation of physical properties of bioparticles will be carried out using SEM, N2 adsorption, surface area analysis besides batch study on operational parameters such as flow rate, aeration, pH, temperature and pollutant (dyes, heavy metal, amines, hydrocarbons, excess nutrients) will be carried out to determine the capability of treating different types of pollutant. **2. Flow Chart of Research Activities:** *(Please enclose flow chart in Appendix)* **3. Gantt Chart of Research Activities:** *(Please enclose Gantt Chart in Appendix)* **4. Milestones and Dates:** *(Please enclose Milestone in Appendix)*
2.11	**EXPECTED RESULTS/BENEFITS:** **1. Novel theories/new findings/knowledge:** a) Elucidate mechanism of degradation of xenobiotics (dyes, aromatic hydrocarbons, organics) b) Determination of physical properties of composite materials (zeolite, activated carbon, light weight material and slaked lime. c) Catalogue of microorganisms, 'Beneficial Microbes' (BF) for a. Wastewater treatment b. Biofertilizer c. Renewable energy source d. Animal feed production **2. Research publications:** Journals (International and Local Journals), Thesis (Undergraduate and Post-graduate) 3. **Specific or potential applications:** Bioparticle as filtering media in Biofilter (Patent pending) for industrial wastewater treatment **4. Number of PhD and MSc (by research) Students:** 3 MSc (by research) students

3.0	**UTILISATION OF EXISTING FACILITIES/EQUIPMENT**	**LOCATION: CENTRE OF EXCELLENCE/FACULTY**
	HACH SPECTROFOTOMETER, HORRIBA WATER ANALYZER, COD REACTOR	Research Laboratory (2), Biology Department, Science Faculty

4.0	FUNDING REQUESTED			
	ITEM		JUSTIFICATIONS	AMOUNT (RM)
	11000	Salary and wage	Master Students/ Research Assistants	RM40,000.00
	14000	Overtime	Lab Technicians/ Technicians	RM5,000.00
	21000	Travelling expenses and subsistence	Wastewater Sampling Seminars and workshops Exhibition	RM10,000.00
	22000	Transportation of goods/product specialist	Cosmoballs, light weight material, zeolite, activated carbon, Biofilter fabricated tank	RM5,000.00
	23000	Communications and utilities (phone, fax, postage etc.)	Phone, fax, express postage, inter-library loan, books (wastewater analysis standard methods, latest edition of Bergey's manual of bacteriology, fungal identification), journals	RM10,000.00
	24000	Rental	Equipments for analysis and transport	RM5,000.00
	26000	Supply of raw materials & materials for repair and maintenance	Zeolite, Processed Activated Carbon, Synthetic Light Weight material Laminar flow, microscope, centrifuge, HACH spectrophotometer, COD reactor	RM20,000.00
	27000	Research materials and supplies (including animals, disposables etc)	Nutrient for microorganisms Storage beads for maintaining bacterial cultures Chemicals, reagents	RM10,000.00
	28000	Maintenance and minor repair services	Instrument servicing and troubleshooting	RM20,000.00
	29000	Professional services and other services (including printing and hospitality, registration fees, honorarium for subjects)	Brochure printing, Catalogue printing Bacterial identification, 16S rRNA analysis EM analysis for biofilm (TEM, SEM) AAS and ICPMS analysis NMR analysis for EPS Bioreactor design and accessories	RM40,000.00
	35000	Equipment and accessories	Bioparticle mould, wastewater analyzer, HACH spectrophotometer, Water testing kits,HPLC and GC column, peristaltic pump, aeration pump,mixer	RM40,000.00
	TOTAL (RM)			**RM205,000.00**

SIGNATURE OF PROJECT LEADER

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NAME :
DESIGNATION :
Date:

All applications submitted will be treated with strictest confidentiality and the decision of the Ministry of Higher Education is final.

5.0	SCREENING SUMMARY FROM UTM TECHNICAL EVALUATION COMMITTEE	Insufficient		Acceptable	Very Good	
		1	2	3	4	5
1.	Completeness of application					
2.	Capability & availability of project leader					
3.	Capability & availability of research team					
4.	Scientific merit of research objectives					
5.	Viability of Approach and Methodology					
6.	Fairness of cost estimates					
7.	Utilization of existing resources					
8.	Contribution to knowledge generation					

Further Actions:

- ☐ Proposal to be submitted to the Ministry of Higher Education (as is)
- ☐ Proposal to be resubmitted to RMC after revision / modification
- ☐ Proposal rejected

GENERAL COMMENTS:

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NAME :
Date :

6.0	VERIFICATION BY INSTITUTIONAL COORDINATOR:

GENERAL COMMENTS:

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DEAN
RESEARCH MANAGEMENT CENTRE
Date:

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ABSTRACT

The removal of dyes and others contaminants such as heavy metals from effluent remains a major problem for the textile industry. While coloured organic compounds generally impart only a minor fraction of the organic load to wastewater, their colours renders them aesthetically unacceptable. Many dye compounds and their intermediates are carcinogenic and difficult to remove by conventional wastewater treatment methods. Many physico-chemical methods have been used for textile wastewater treatment. However, they showed some disadvantages such as high treatment cost, low efficiency to a wide range of dyes and toxic sludge generation. Bioremediation based on microbial technologies for treating textile wastewater promise satisfactory contaminants removal due to the biodegradation and mineralization of contaminants into non-toxic compounds.

Therefore, this research has focused on bioremediation of textile wastewater, especially in colour and heavy metals removal, using biofilm. The potential dye-degrader and heavy metal removal bacterial strains were first isolated from textile effluents. Screening studies of isolated strains for dye decolourization and heavy metals removal were carried out using filter sterilized textile effluent and simulated textile wastewater in batch scale. Further more, the selected bacterial strains were grown as biofilm on support matrices and the biofilm were used for bioremediation of textile wastewater in lab scale experiments. The biofilm structure was examined using electron-scanning microscope (SEM). Parameters such as colour intensity, aromatic amines, COD, BOD, pH, cadmium, copper, nitrate, phosphate, sulphate content were monitored during the experiment.

Generally, it was found that there are three strains of bacteria, namely *Bacillus cereus*, *Aeromonas caviae* and *Aeromonas hydrophilla*, showed a good performance in decolourizing and degrading dyes. Besides, they were also able to remove heavy metals

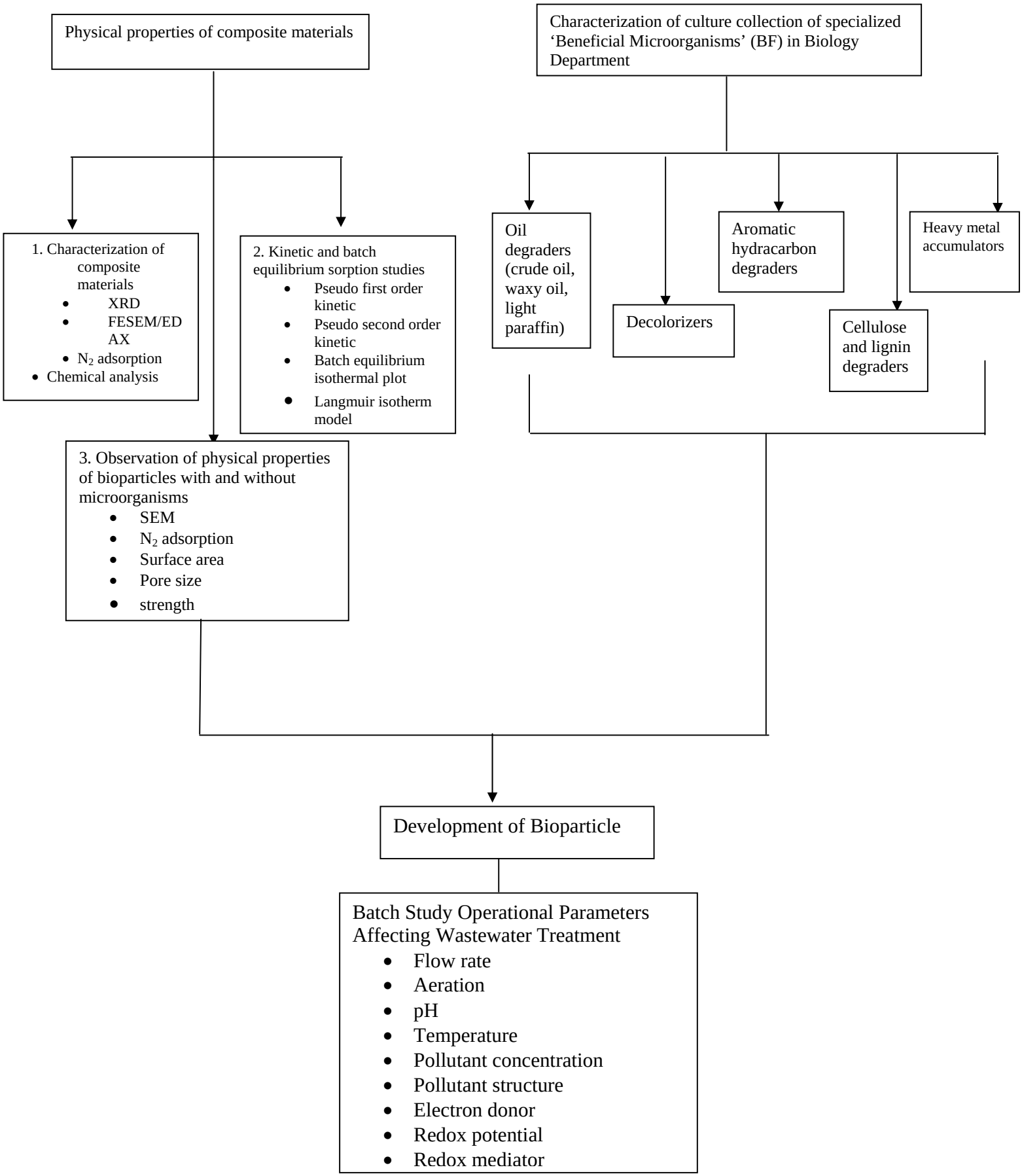
such as cadmium and copper. The maximum removal efficiency in lab scale experiments for colour intensity, COD, BOD, cadmium, copper, nitrate, phosphate and sulphate were 80.0%, 71.9%, 45.5%, 52.1%, 54.1%, 98.0%, 58.5% and 59.5%, respectively. Furthermore, mechanisms for biodegradation of dye showed all of them remove colour via reduction of dyes. This was confirmed by detecting the degradation products through High Performance Liquid Chromatography (HPLC). In addition, gene responsible for desulphonation was successfully amplified via PCR from *Aeromonas hydrophila* and thus confirmed this strain was able to remove sulphonated dyes efficiently.

ABSTRAK

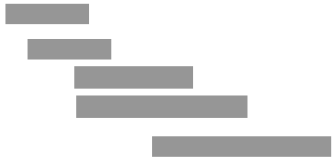
Penyingkiran pewarna dan bahan pencemar lain seperti logam berat daripada efluen masih menjadi masalah utama dalam industri tekstil. Manakala, bahan organik berwarna umumnya merupakan sebahagian kecil daripada pencemar organik dalam air sisa. Bahan pencemar organik berwarna ini menjadikannya tidak diterima dari segi estetik. Kebanyakan bahan pewarna dan bahantaranya adalah karsinogenik dan sukar untuk disingkirkan melalui kaedah konvensional rawatan air sisa. Banyak kaedah fizikal dan kimia telah digunakan untuk merawat air sisa tekstil. Namun, ia menunjukkan beberapa kekurangan seperti kos rawatan yang tinggi, keberkesanan yang rendah terhadap keperbagaian pewarna dan penghasilan *sludge* yang toksik. Bioremediasi berasaskan kepada penggunaan teknologi mikroorganisma untuk merawat air sisa tekstil menjanjikan kepuasan dalam penyingkiran bahan pencemar. Ini disebabkan oleh biodegradasi dan mineralisasi bahan pencemar kepada bahan tidak toksik.

Oleh itu, kajian ini telah memfokuskan kepada bioremediasi air sisa tekstil, terutamanya dalam penyingkiran warna dan logam berat menggunakan biofilem. Potensi bakteria yang berupaya menyingkirkan pewarna dan logam berat telah dipencilkan dahulu daripada efluent tekstil. Kajian penyaringan bakteria yang dipencilkan untuk penyahwarnaan pewarna dan penyinkiran logam berat telah dijalankan ke atas air sisa tekstil yang disterilkan melalui penurasan dan air sisa tekstil simulasi dalam skala sesekelompok. Di samping itu, bakteria terpilih telah ditumbuhkan sebagai biofilem di atas matrik penyokong dan biofilem itu telah digunakan untuk bioremediasi air sisa tekstil dalam eksperimen skala makmal. Struktur biofilem telah diperiksa menggunakan mikroskop pengimbas electron (SEM). Parameter-parameter seperti warna, amina aromatik, COD, BOD, pH, kadmium, kuprum, kandungan nitrat, fosfat dan sulfat telah diukur semasa eksperimen.

Umumnya, didapati bahawa terdapat tiga jenis bacteria iaitu *Bacillus cereus, Aeromonas caviae* dan *Aeromonas hydrophilla* menunjukkan hasil yang baik menyahwarna dan degradasi pewarna. Selain itu, ia juga berupaya untuk menyingkirkan logam berat seperti kadmium dan kuprum. Keberkesanan penyingkiran yang maksimum dalam eksperimen skala makmal untuk warna, COD, BOD, pH, kadmium, kuprum, kandungan nitrat, fosfat dan sulfat adalah 80.0%, 71.9%, 45.5%, 52.1%, 54.1%, 98.0%, 58.5% and 59.5% masing-masing. Tambahan pula, mekanisma untuk biodegradasi pewarna ini menunjukkan semuanya menyingkirkan pewarna melalui pemecahan ikatan pewarna azo. Ini telah dipastikan dengan mengesan hasil degradasi melalui kromatografi cecair berprestasi tinggi (HPLC). Selain itu, gen yang bertanggungjawab untuk penyahsulfonan telah berjaya diamplifikasikan melalui teknik PCR daripada *Aeromonas hydrophilla* dan seterusnya membuktikan strain ini berupaya untuk menyingkirkan pewarna sulfonat dengan berkesan.


Physical properties of composite materials
Characterization of culture collection of specialized 'Beneficial Microorganisms' (BF) in Biology Department
1. Characterization of composite materials
XRD
FESEM/EDAX
N_2 adsorption
Chemical analysis
2. Kinetic and batch equilibrium sorption studies
Pseudo first order kinetic
Pseudo second order kinetic
Batch equilibrium isothermal plot
Langmuir isotherm model
Oil degraders (crude oil, waxy oil, light paraffin)
Decolorizers
Aromatic hydracarbon degraders
Cellulose and lignin degraders
Heavy metal accumulators
3. Observation of physical properties of bioparticles with and without microorganisms
SEM
N_2 adsorption
Surface area
Pore size
strength
Development of Bioparticle
Batch Study Operational Parameters Affecting Wastewater Treatment
Flow rate
Aeration
pH
Temperature
Pollutant concentration
Pollutant structure
Electron donor
Redox potential
Redox mediator

MILESTONE

NO.	PROJECT ACTIVITIES	YEAR (2year schedule)
		Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8
1.	Characterization of culture collection of specialized 'Beneficial Microorganisms' (BF) a) Identification of microorganisms (Biochemical Tests, 16S sRNA) b) Degradation mechanisms determination c) Optimization of culture collection methods d) 'Beneficial Microorganisms' cataloguing	
2.	Characterization of composite materials (zeolite, processed activated carbon, synthetic light weight material, slaked lime) a) Physical properties observation (SEM,EDAX, N_2 adsorption) b) Chemical analysis (acid-base tests) c) Kinetic and batch equilibrium sorption studies d) Observation of physical properties of bioparticle with and without incorporated microorganisms e) Batch study on bioparticle operational parameters (flow rate, aeration,pH, temperature, pollutant concentration and structure, electron donor, redox mediator and redox potential). Notes : Q1 : First Quarter (Jan, Feb, Mar), etc.	

MILESTONE

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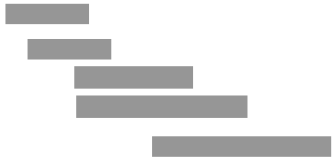
2.	Characterization of composite materials (zeolite, processed activated carbon, synthetic light weight material, slaked lime) a) Physical properties observation (SEM,EDAX, N_2 adsorption) b) Chemical analysis (acid-base tests) c) Kinetic and batch equilibrium sorption studies d) Observation of physical properties of bioparticle with and without incorporated microorganisms e) Batch study on bioparticle operational parameters (flow rate, aeration,pH, temperature, pollutant concentration and structure, electron donor, redox mediator and redox potential). Notes : Q1 : First Quarter (Jan, Feb, Mar), etc.	

GANTT CHART OF RESEARCH ACTIVITIES

Time / Activities	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
Characterization of culture collection								
Determination of degradation mechanisms								
Establish culture collections technique								
Study on properties of composite materials								
Characterization of composite materials								
Kinetic and batch equilibrium sorption studies								
Observation of bioparticle properties with and without incorporated microorganisms								
Batch study operational parameters affecting wastewater treatment