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Date: 15/07/2024

CERTIFICATE

This is to certify that the research work presented in thesis entitled “*Nano-additives to improve the Flow and Thermal Properties of Different Oils*” submitted by **Mr. Vishal Sureshkumar Vora** for the award of the degree of **Doctor of Philosophy in Applied Chemistry** includes the original research work carried out by him under my supervision in the Department of Applied Chemistry, Faculty of Technology and Engineering, The Maharaja Sayajirao University of Baroda, Vadodara-390001, Gujarat, INDIA.

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DECLARATION

I hereby declare that the content in the thesis entitled “*Nano-additives to improve the Flow and Thermal Properties of Different Oils*” is a result of the study carried out by me at the Department of Applied Chemistry, Faculty of Technology and Engineering, The Maharaja Sayajirao University of Baroda, Vadodara, Gujarat, India under the supervision of **Dr. Rakesh K. Sharma**.

No part of this thesis is submitted elsewhere for the award of any other degree. Any omission, which might have occurred by oversight or error, is regretted.

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I declare that the similarity report is found to be **07%** via "**DrillBit**," which comes under the allowable notified range by the University Grants Commission (UGC), New Delhi. This research work has been carried out by **Mr. Vishal Sureshkumar Vora** under my supervision at the Department of Applied Chemistry, Faculty of Technology and Engineering, The Maharaja Sayajirao University of Baroda.

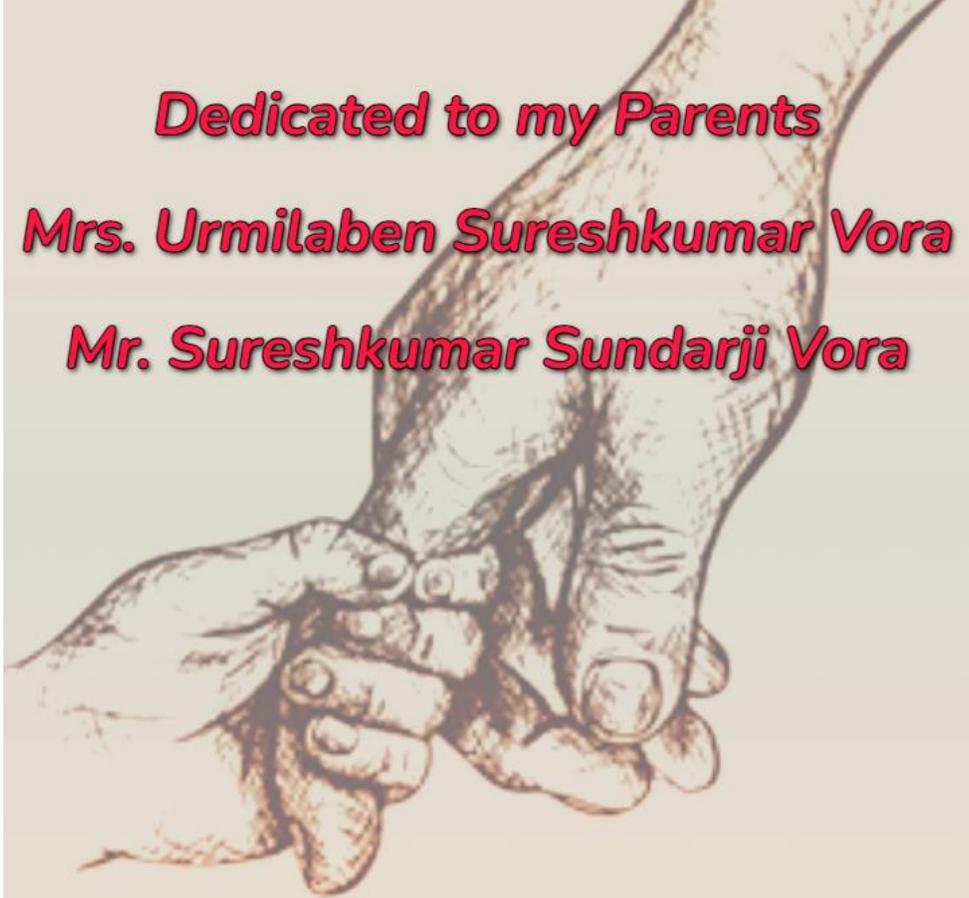
Yours sincerely,

Dr. Rakesh K. Sharma
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Dedicated to my Parents

Mrs. Urmilaben Sureshkumar Vora

Mr. Sureshkumar Sundarji Vora



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-Mr. Vishal Sureshkumar Vora

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List of Abbreviation

AFA	: Anti-foaming agent
API	: American petroleum institute
ASTM	: American Society for Testing and Materials
AO	: Anti-oxidants
AW	: Anti-wear
BO	: Base oil
BN	: Boron nitride
CO	: Castor oil
CNTs	: Carbon nanotubes
D	: Dilatant
EDX	: Energy dispersive x-ray spectroscopy
EO	: Engine oil
EP	: Extreme pressure
FMs	: Friction modifiers
FWHM	: Full width at half maximum
GNP	: Graphene nanoplatelets
ICDD	: International centre for diffraction data
FHC	: Fluorinated hydrocarbon
KOH	: Potassium hydroxide
KI	: Potassium iodide
m	: Consistency index
MO	: Mineral Oil
MTPS	: Modified transient plane source
MWCNT	: Multiwalled carbon nanotubes
N	: Newtonian
n	: Power law index
NO	: Natural oil
OdW	: Ostwald–de Waele
PAG	: Poly alkylene glycol

PAO	:	Poly alpha olefin
PEG	:	Poly ethylene glycol
PFPE	:	Perfluoro polyether
PLGA	:	Poly (lactic-co-glycolic acid)
PMA	:	Poly alkyl methacrylate
PMMA	:	Poly (methyl methacrylate)
PP	:	Pseudo plastic
PPD	:	Pour point depressants
PS	:	Poly styrene
PSS	:	Poly styrene sulfonate
PTFE	:	Poly tetrafluoro ethylene
PVA	:	Poly vinyl alcohol
PVP	:	Poly vinyl pyrrolidone
R&CI	:	Rust and corrosion inhibitors
SAE	:	Society of automotive engineers
SEM	:	Scanning electron microscopy
SHC	:	Synthetic hydrocarbon
SiO	:	Silicone oil
SO	:	Synthetic oil
S.V.	:	Saponification value
SS	:	Stainless steel
VI	:	Viscosity index
WS2	:	Tungsten disulfide
TCP	:	Tricresylphosphate
WoS	:	Web of Science
XRD	:	X-ray diffraction
ZDP	:	Zinc dithiophosphate
ZDDP	:	Zinc dialkyldithiophosphate