The applications of butyl titanate in the paint and allied industries have been developed considerably in the last twenty years but very little attention has been given to the theoretical aspects of these problems. The author, therefore, undertook a complete study of the properties of butyl titanate which have a direct bearing on its applications in thermostable coatings, thixotropic paints and as a polymerisation catalyst.

The thesis consists of three parts. In part I the preparation and properties of butyl titanate are described. Part II deals with butyl titanate as a polymerising agent for linseed oil. Applications of butyl titanate in thermostable coatings and thixotropic paints are discussed in part III of the thesis.

Preparation of titanium tetrachloride, the starting material and that of butyl titanate is described. Optimum conditions for preparation of titanium tetrachloride using titanium dioxide and coke were determined and mechanism of the reaction between chlorine and titanium dioxide and the part played by coke in this reaction was studied. Conditions for synthesis of pure butyl titanate were established.

The reported information on physico-chemical properties of alkyl titanates being meagre, detailed study of ultraviolet and infrared absorption spectra and of structural change as a result of thermal treatment, was made. Spectrophotometric grade reagents were prepared for this study. Ultraviolet absorption studies were made for the first time. Although the absorption peak in both the cases was observed to be at 237 millimicrons, it was sharp in butyl alcohol but broad in ethyl alcohol. Beer's law was obeyed suggesting the possibility of using this method for the estimation of butyl titanate.

Experiments were done for determining butyl titanate in linseed oil. The molecular extinction coefficients in butyl alcohol and ethyl alcohol were approximately 9300 and 8000 respectively.

The infrared absorption spectrum of butyl titanate showed characteristic peaks in the region 5.9, 6.7 and 8.4 microns due to C=O, Ti=O-C and Ti-O groups. A peak observed at 13.3 microns was assigned to O-Ti-O group.

A detailed study of thermal behaviour of the hydroxysalt of butyl titanate was undertaken with a view to obtain evidence for the formation of brookite, one of the three
crystalline forms of titanium dioxide which is available only in nature and it is reported that it can be prepared by hydrolysis of alkyl titanates. Endothermic peaks due to loss of loosely held water and water of hydration and exothermic peaks as a result of various structural changes taking place were observed. A new exothermic peak at 315°C was observed in the thermogram of the hydrolyzate of butyl titanate. This was not reported by the earlier workers in the differential thermal analysis curves of the hydrated titanium dioxide. The changes were further followed up by X-ray diffraction studies. The study showed that butyl titanate when hydrolyzed and heated yields anatase.

The suitability of butyl titanate as a catalyst for the polymerisation of linseed oil which is a major oil used in paint industry was thoroughly investigated. The extent and nature of polymerisation was followed by changes in viscosity, colour, refractive index and ultraviolet absorption spectra.

It was observed from the viscosity data that the polymerisation in presence of butyl titanate takes place in two stages. The rate of change of viscosity indicates that polymerisation is linear in the first stage followed by three dimensional polymerisation in the second stage. In some cases there is a time lag between the two stages.

The higher polymer formation is related to double bond functionality of the linseed oil. Viscosity data indicates that effective double bond functionality is maximum on addition of 0.2 percent butyl titanate and decreases with increase in proportion of the titanate. This is explained assuming dimerisation by addition of conjugated double bond to a non-conjugated double bond resulting in lower double bond functionality than if dimerisation takes place by addition reaction between two conjugated double bonds. The examination of ultraviolet and infrared absorption spectra of polymerised product shows that polymerisation at the conjugated trans-trans bonds is instantaneous but that at the isolated trans bond it is slow. The cis-cis conjugated bonds are not polymerised and as a result the product shows preponderance of cis-cis conjugated double bonds. Butyl titanate has oxidising action on the oil when used in higher proportions and on heating for longer duration, with consequent increase in colour. Addition of 0.2 percent butyl titanate and heating at 250°C for 10 hours is recommended to get a polymerised oil having satisfactory colour and viscosity.
Application of butyl titanate in thermostable coatings was studied. When used with aluminium paint, it was observed that even 0.1 percent butyl titanate was sufficient to give desired adhesion of paint with the underlying surface which improved on exposure to high temperature.

A detailed study of the use of butyl titanate as a promoter of thixotropy in the paint formulation using rutile and anatase and linseed oil, showed that the paints which are non-thixotropic, completely change to thixotropic paints in presence of butyl titanate. The sol to gel and gel to sol transformation of the paint, an essential feature of the thixotropic system was followed by viscosity changes. 0.5 percent butyl titanate was observed to be optimum for obtaining the desired thixotropy.

When butyl titanate is added to a non-thixotropic paint containing rutile or anatase and linseed oil, a part of butyl titanate hydrolyses to form titanium hydroxide which being more reactive than the titanium dioxide pigment gets adsorbed on the pigment particles and stabilises the titanium dioxide sol. Butyl titanate also induces gel formation. It dissociates weakly into butyl and titanate ions. While butyl ions have affinity for linseed oil and remain dispersed in the oil, titanate ions are attracted towards pigment particles. Due to the weak dissociating nature of butyl titanate butyl ions are not very far removed from titanate ions and remain in the neighbourhood of pigment particles along with the oil molecule. Thus butyl titanate acts as a link between pigment and vehicle oil. Since titanium ion is tetravalent, at least four linseed oil poly molecules are associated with each pigment particle when only one butyl titanate molecule is adsorbed on them. The oil thus loses its mobility and the system becomes viscous. When stress is applied, the system is disturbed, titanate and butyl ions are separated and the oil gains its mobility, the viscosity decreases and gel to sol transformation takes place.

Thus the above study gives an insight into the part played by butyl titanate in the catalytic polymerisation of linseed oil and thixotropy of rutile and anatase paints.