Conclusions

The important conclusions resulting from this research work can be summarized as follows

**Natural rubber**

1) When cardanol is used as plasticizer for HAF black filled NR in place of aromatic oil, lower cure time, compound viscosity and filler agglomeration result. Cardanol also leads to higher cure rate indices.

2) The mechanical properties are in general better than when aromatic oil is used.

3) The percentage of cardanol needed for plasticizing HAF black filled NR is only 5% as against 10% for aromatic oil.

4) Cardanol leads to better ageing characteristics compared to aromatic oil.

5) In the case of silica filled NR, similarly, cure time and $\alpha$ values are lower for cardanol.

6) Mechanical properties and thermal stability are similar for both cardanol and aromatic oil based samples.

7) The amount of cardanol needed for plasticizing silica filled NR is 10% of filler weight, same as that of aromatic oil.

8) For both silica filled and black filled compounds, the ageing behaviour of the vulcanizates is better when cardanol is used as plasticizer.

9) Performance of cardanol is equivalent to that of TQ and SP when antioxidant properties are considered.

10) The co-activator properties of cardanol in NR are comparable to stearic acid.
Conclusion

11) The crosslinking density of cardanol plasticized NR is generally lower than when plasticized by atomic oil.

NBR

1) For HAF black filled NBR, cure characteristics and $\alpha$ values are similar to those obtained when DOP is used as plasticizer.

2) Mechanical properties are also of comparable magnitude.

3) For silica filled NBR, compound viscosity and $\alpha$ values are lower for the case of cardanol.

4) The mechanical properties are superior when cardanol is used.

5) The crosslink densities are comparable for both DOP and cardanol for both fillers.

6) 10% cardanol is needed for plasticizing HAF black where as 5 - 7.5% is needed in the case of silica. The latter case compares well with DOP which is required to the extent of 10%.

7) Cardanol possesses antioxidant and co-activator properties in NBR comparable to conventional additives.

8) Cardanol has some activator property in NBR compounds.

EPDM

1) Cure characteristics and mechanical properties are similar for cardanol and naphthenic oil, the two plasticizers studied.

2) In the case of silica filled EPDM, cardanol shows superiority at high silica contents greater than 20phr.

3) The amount of cardanol required for plasticization is 5% for both fillers, which is the same as that used for conventional plasticizers.

4) Cardanol possesses co-activator and accelerator properties comparable to conventional additives.
Conclusion

CR

1) For CR, cardanol gives similar cure characteristics and mechanical properties as naphthenic oil.

2) Cardanol plasticized samples show better ageing behaviour compared to naphthenic oil based samples.

3) For black filled compounds, filler dispersion is more effective in the case of cardanol.

4) Silica filled CR has a tendency to adhere to the mould surface.

5) Optimal amount of cardanol in HAF black filled CR is 10%.

6) Cardanol possesses antioxidant and co-activator properties in CR compounds. It has also some accelerator property.

Comparative performance

1) Lowering of cure time is maximum in the case of black filled CR when cardanol is used as plasticizer.

2) Improvement in mechanical properties are comparatively better when cardanol is used for silica filled compounds rather than black filled compounds

3) Maximum retention of tensile strength after ageing at 100°C is observed in the case of black filled EPDM followed by NR and CR when plasticized by cardanol.

4) In general, cardanol shows much lower extractability compared to conventional plasticizers.

5) First order kinetics of rubber vulcanization is not altered by the presence of cardanol