CHAPTER FOUR

RESULT AND DISSCUTION

4.1Introduction:

This chapter presents a performance based comparative study of various fuzzy logic controllers (FLCs) to control the speed of squirrel-cage induction motor (SCIM) by replacing the conventional proportional−integral (PI) controller. The fuzzy logic based controller does not require any identification of motor dynamic to control its speed and also assures the disturbance rejection with high robustness. Performances of the pi fuzzy controllers are also compared with the conventional PI speed controller in terms of several performance measures such as peak overshoot (Mp %), settling time (Ts) at different values of load. The simulation results show the effectiveness of the performance of pi fuzzy controller. From MATLAB SIMULINK of indirect vector control shown in appendix B, Theses results below taken.

System layout

The parameters of the motor used for the simulation in MATLAB are shown in table 2.

The block diagram of indirect vector control of induction motor using fuzzy logic PI controller and PI controller designed in MATLAB/SIMULINK is shown in Fig 4.1

Table.2 Induction motor parameters

Values	Parameters
P=7.4 KW	Rated Power
V rated=575volt	Volt Rates Voltage
Rs=0.9174Ω	Stator Resistance
Rr=0.6258 Ω	Rotor Resistance

Ls=00.005473 H	Stator Inductance
Lr=0.005473 H	Rotor Inductance
Lm=0.1854 H	Magnetizing Inductance
Vdc=780 V	DC link Voltage
f=60 Hz	Frequency
J =0.05 $Kg2$	Inertia
B =0.005879 $Kg2/\ sec$	Friction
P=2	Number of poles

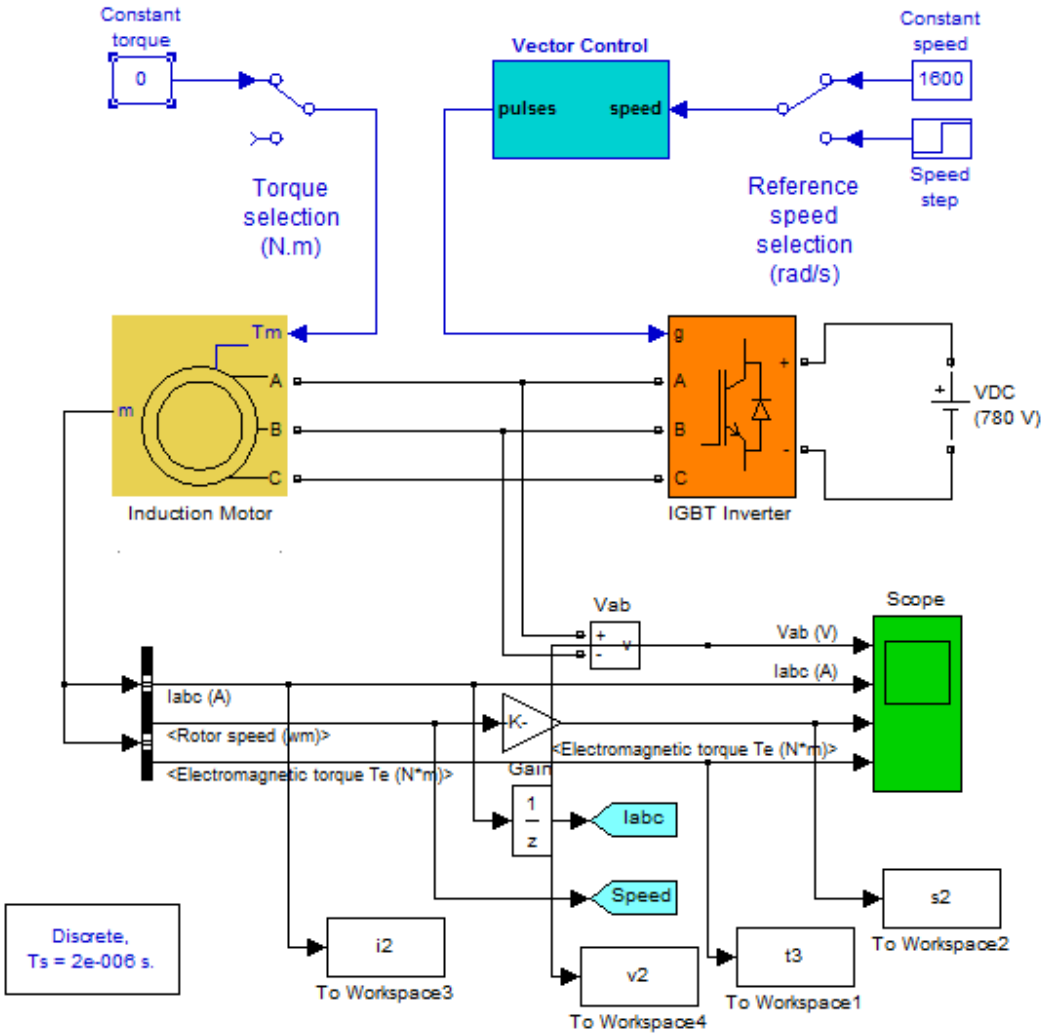

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Figure 4.1 block diagram of indirect vector control of induction motor

4.2Fuzzy PI controller results

Figures4.2, 4.3 and 4.4 show the motor Speed, torque and stator current versus time plot with reference speed1600rad /sec at no load respectively. It is noted that from the figures (4.2, 4.3 and4.4) while using the Fuzzy PI Controller:

Speed rises up 1600rad/sec (reference speed) at starting, then reaches 1600rad/sec after t=1 sec. Torque goes up to 500N-M at starting, then settles to 60 N-M after 1 sec. Stator current goes up to210amp, and then settles to 35 amps after 1 sec.

Figures 4.4, 4.5and 4.6 represent motor speed, torque and stator current with reference speed1600rad /sec when applying load (30N.m) at t=1.05 sec.

It can be seen from the figures (4.5, 4.6 and4.7) that while using the Fuzzy pi Controller:

Speed drops to 1400rad/sec and then settles to the reference speed (1600rad/sec) at 1.4sec,

Torque (Te) rises up to 116N-m and then settles to 60N-m after t=1.1sec.

Table 3 Performance analysis of Fuzzy PI at 0NM and 30NM

load(NM)	Ts(sec)	MP(%)
0	1.1	0.0312
30	1.4	0.125

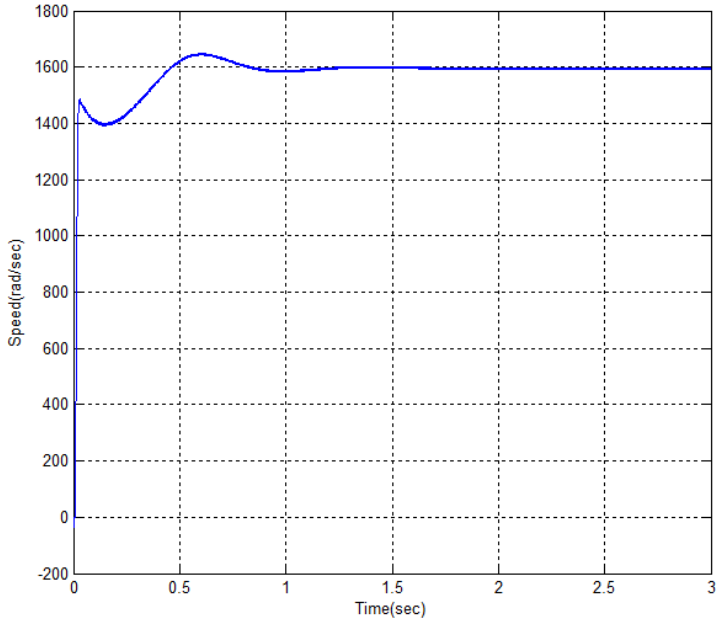

Figure 4.2motor speed when using fuzzy pi controller at no load

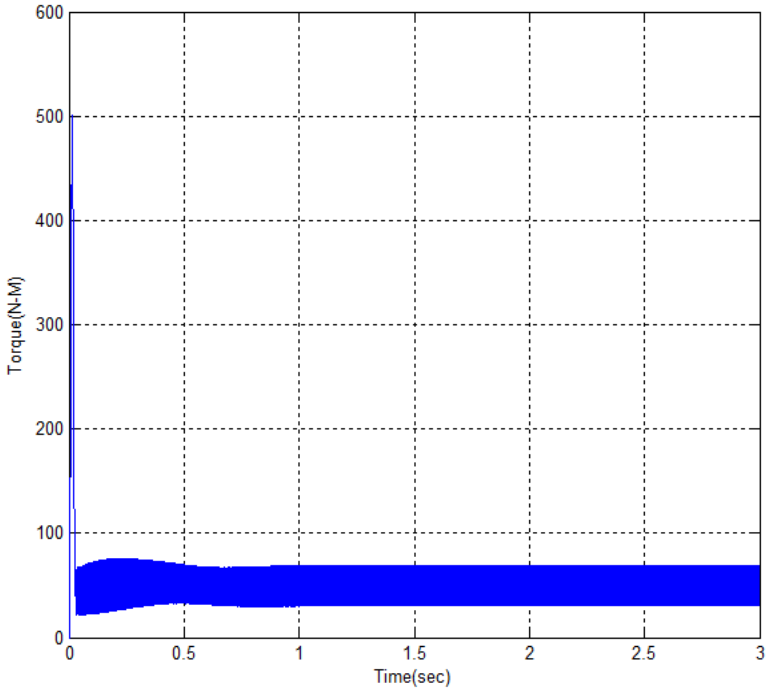

Figure 4.3 torque when using fuzzy pi controller at no load

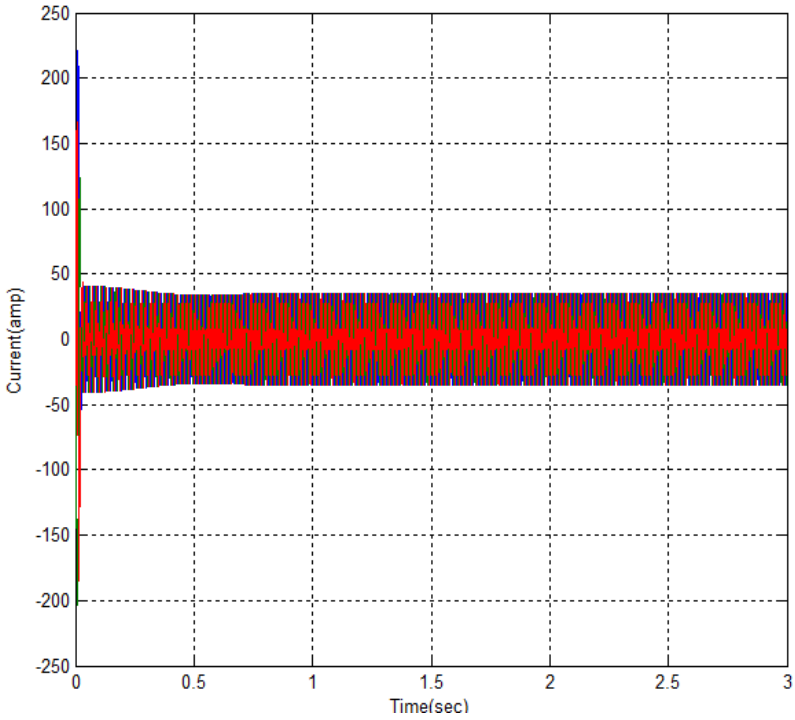

Figure 4.4Stator current when using Fuzzy PI controller at no load

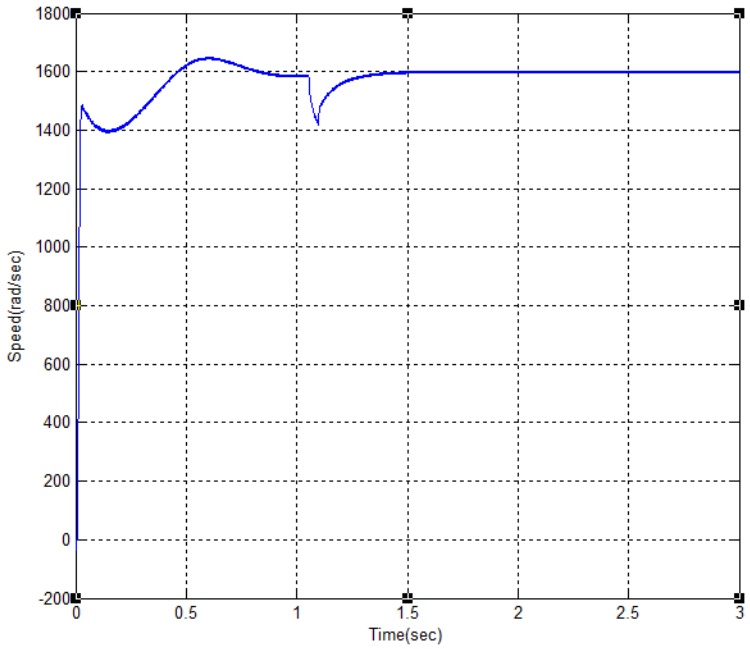

Figure 4.5 motor speed when using Fuzzy pi control at load =30N-m, at time t=1 sec.

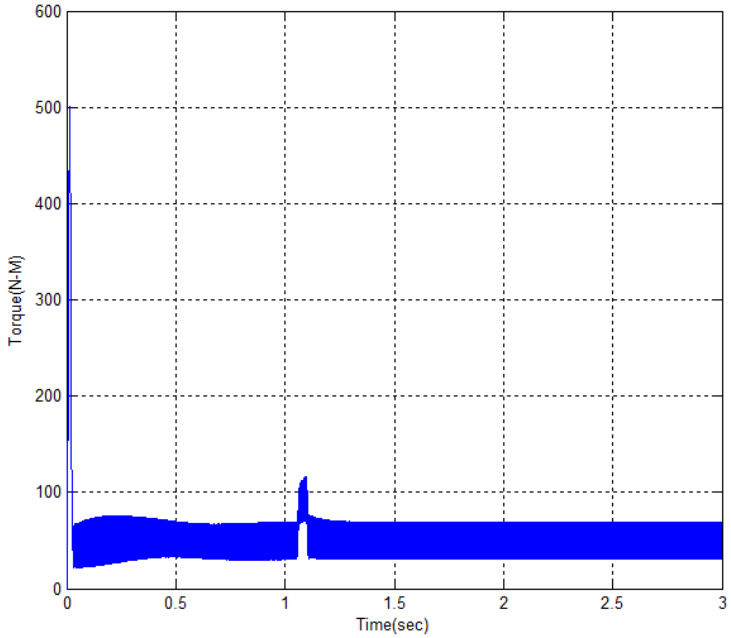

Figure 4.6 torque when using Fuzzy pi control at load =30N-m, at time t=1 sec

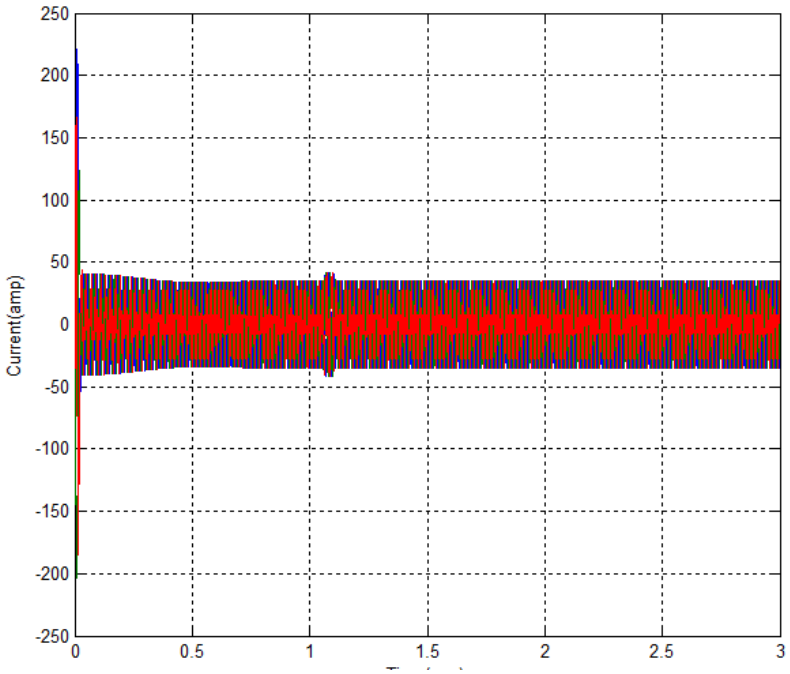

Figure 4.7 stator current when using Fuzzy pi control at load toad=30N-m, attime t=1 sec.

4.3PI results

Figures4.8, 4.9 and 4.10 represent the motor Speed, torque and stator current with reference speed1600rad /sec at no load respectively.

It can be noted from the figures (4.8, 4.9 and4.10) while using the pi Controller:

Speed rises up to 1600rad/sec (reference speed) at starting, then reaches 1600rad/sec after t=2.1 sec.

Torque goes up to 500N-m at starting and then settles to70 N-M after 2.1sec.

Stator current goes up to240amp, and then settles to 45 amps after 2.1sec.

Figures 4.11, 4.12and 4.13, show the results of motor speed, torque and stator current with reference speed1600rad /sec, when applying load (30N.m) at t=1.5 sec.

It can be seen from the figures (4.11, 4.12and4.13) while using the pi Controller:

Speed drops to 1300rad/sec at 1.5 and then settles to the reference speed after 2.57sec.Stator current (I_{abc}) rises up to48amp at 1.5 and then settles to 45 amp after t= 2.7 sec. Torque (Te) rises over 124N-m at 1.5 and then settles at 30N-m after t=2.7sec.

Table 4 Performance analysis of PI at 0NM and 30NM

load(NM)	Ts(sec)	MP(%)
0	2.6	0.125
30	3	0.25

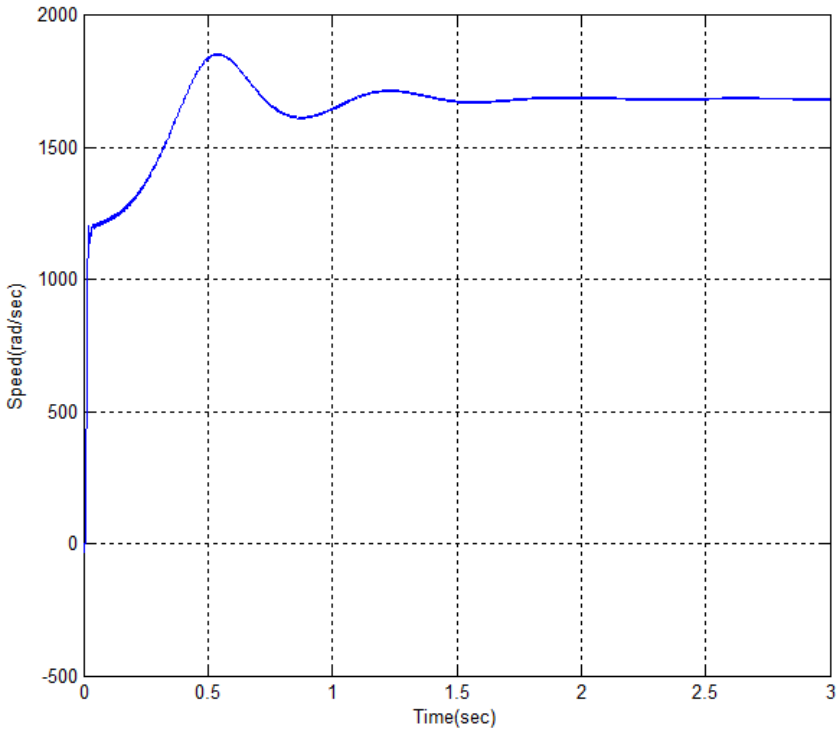

Figure 4.8 motorSpeed when using pi controller at no load

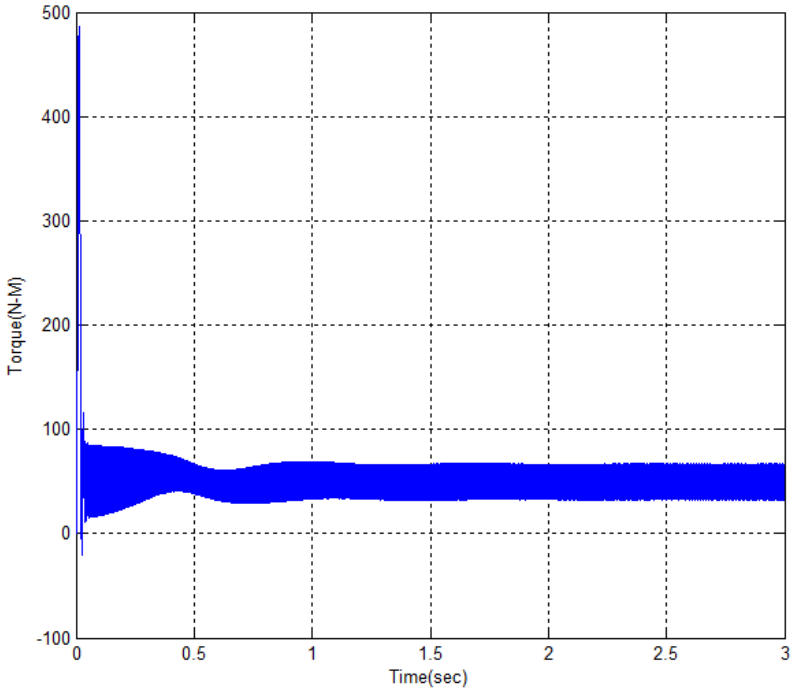

Figure 4.9 Torque when using pi controller at no load

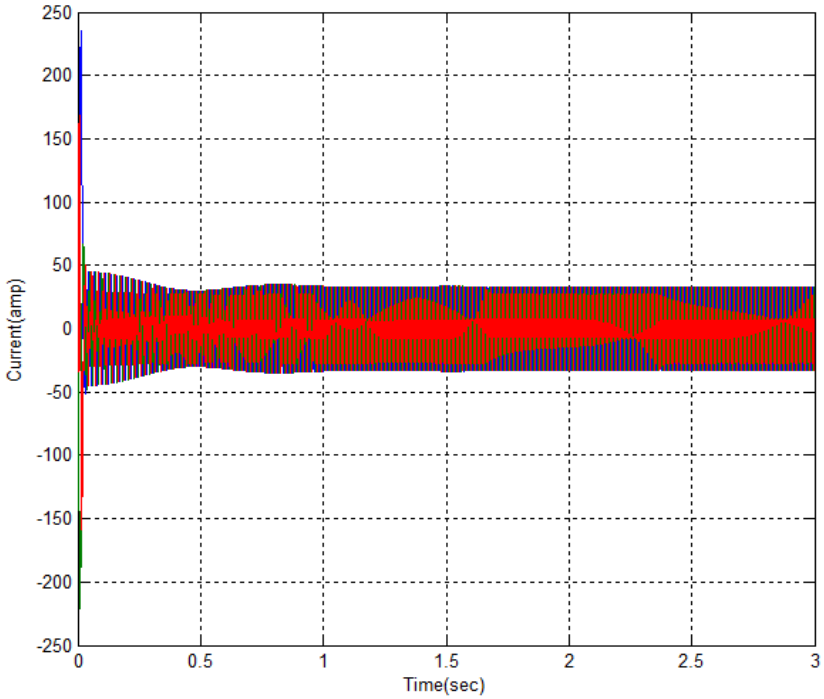

Figure 4.10 Stator current when using pi controller at no load

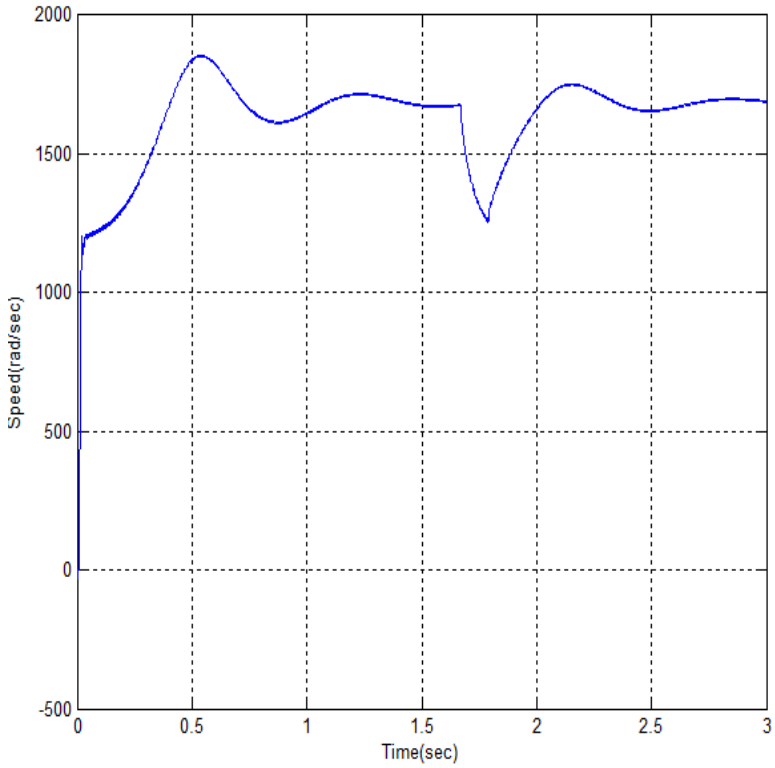

Figure 4.11 speed when using pi controller at load =30N-m, at time t=1.5 sec.

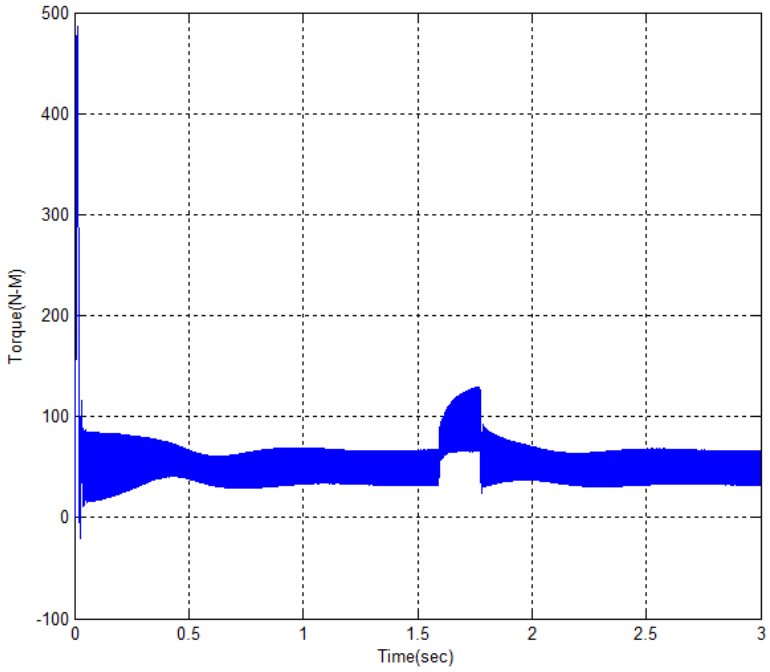

Figure 4.12torque when using pi controller at load =30N-m, at time t=1.5 sec.

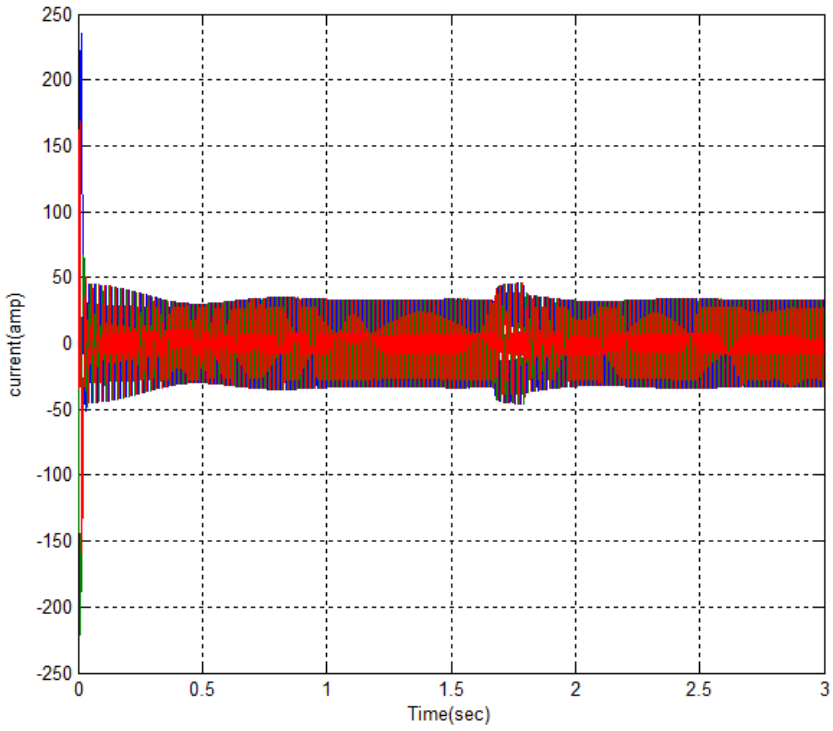

Figure 4.13 stator current when using pi controller at load =30N-m, at time t=1.5 sec.

4.4 Comparison between Fuzzy PI and PI Controller Results

Figures 4.14, 4.16and4.18show the speed response, torque and stator current of induction motor when applying load 30N-m at t=2.5 sec and removing at 5sec with reference speed 1600rad/sec.

It is noted that from the figures (4.14, 4.16 and 4.18) when using the pi Controller:

Speed goes dawn to 1000rad/sec at 2.5, when the applied load was removed; the motor speed went up2000rad/sec and then settles to the reference speed after 6sec.

Torque will increase over 200N-m when applying load, when the load removed at 5 sec torque will decrease under 20N-m and then settles after 6sec.

Stator current (I_{abc}) rises up to50amp when applying load, when the applied load was removed the stator current goes dawn to 30 amp and then settles after6 sec.

Figure 4.15, 4.17and 4.19show the speed response, torque and stator current of induction motor when applying load 30N-m at t=1 sec and removing at 1.9sec with reference speed 1600 rad /sec.

It can observe from the figures (4.15, 4.17and 4.19) while using the fuzzy pi Controller: Speed goes dawn to 1570rad/sec at 1sec, when the applied load was removed; the motor speed went up1680rad/sec and then settles to the reference speed at 2.4sec.Torque will increase over 30N-m when applying load, when the load removed at 5 sec, torque will decrease under35N-m and then settles at 2.4sec.

Stator current rises up to35amp when applying load, when the applied load was removed the stator current goes dawn to 40 amp and then settles at 2.4 sec.

Table 5 Performance analysis of IM at 0NM and 30NM

controller	Ts(sec)		MP (%)	
	Applying load(30NM)	Removing load(30NM)	Applying load(30NM)	Removing load(30NM)
PI	4.6	6.5	0.375	0.187
Fuzzy PI	1.2	2.4	0.o31	0.062

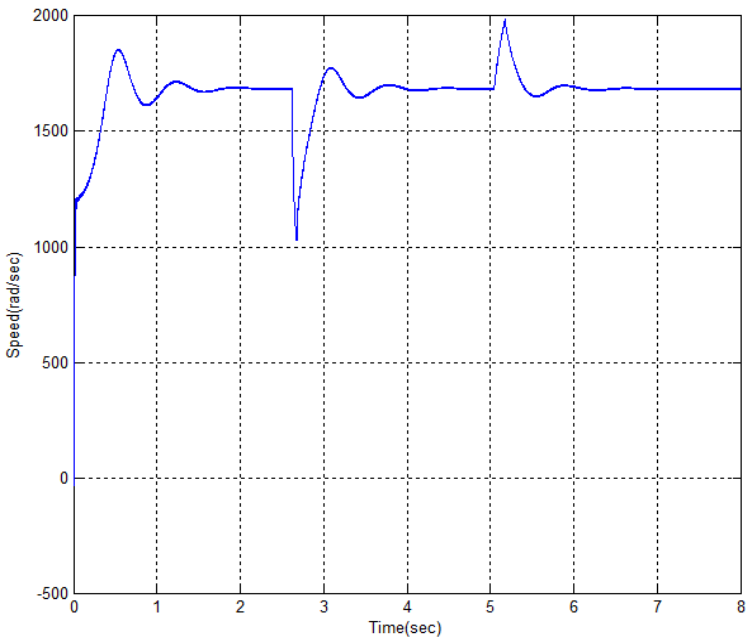

Figure 4.14motor speed when applying load(30N-m) at t=2.5 sec and removing at 5sec.

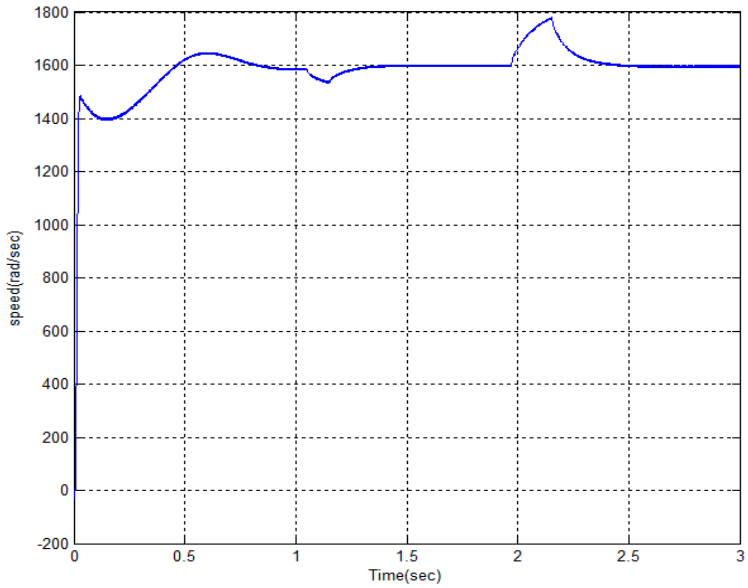

Figure 4.15 motor speed when applying load torque (30Nm) at t=1 sec and removing at 1.9sec.

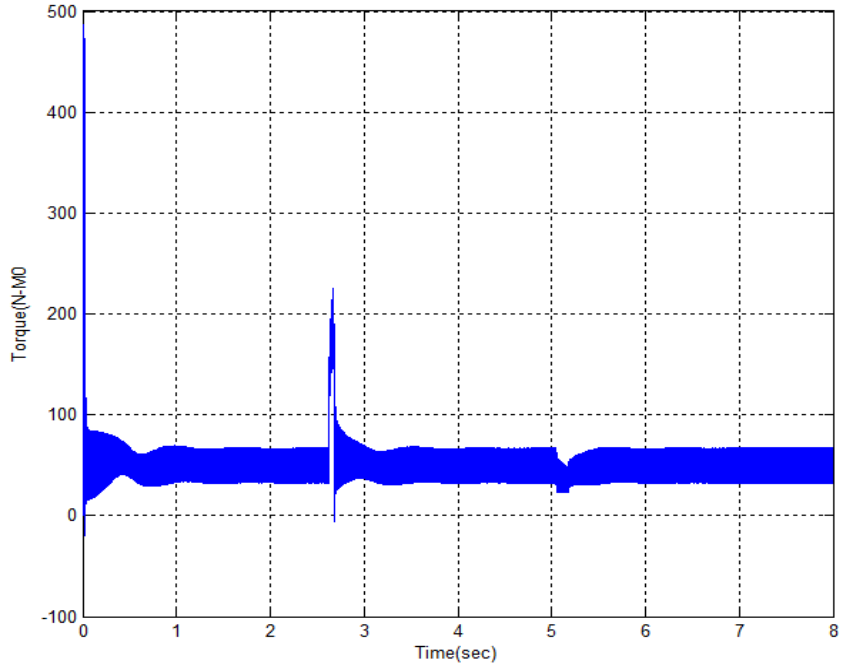

Figure 4.16torque when applying load (30N-M)at2.5sec and removing at 5sec

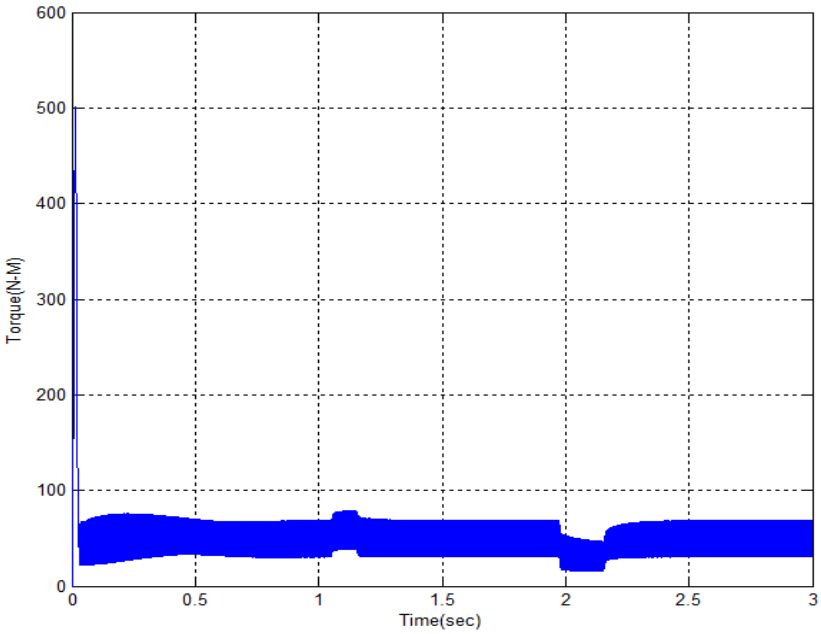

Figure 4.17torque when applying load(30N-M) at1sec and removing at 1.9sec

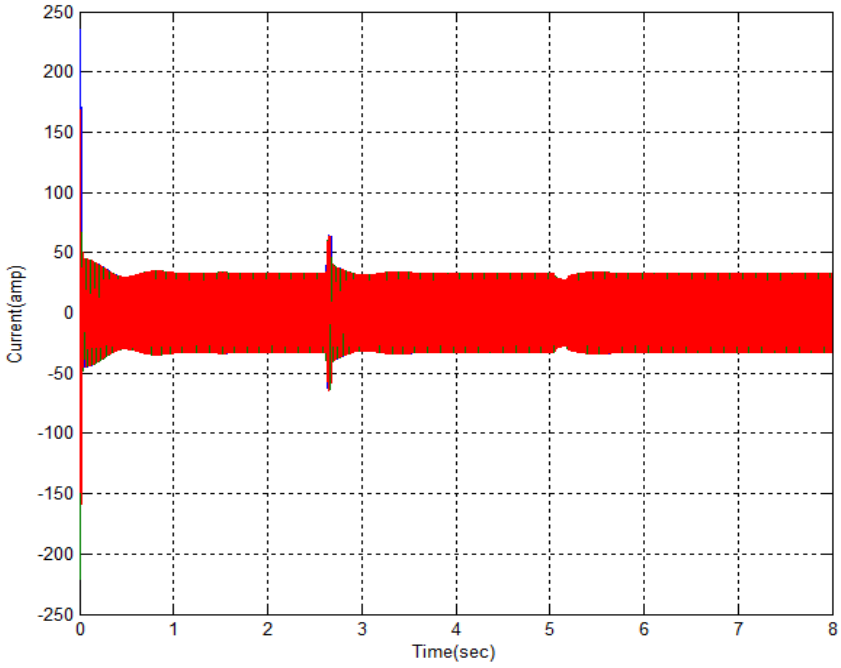

Figure 4.18 Stator current when applying load (30N-M) at 2.5 andremoving at 5sec.

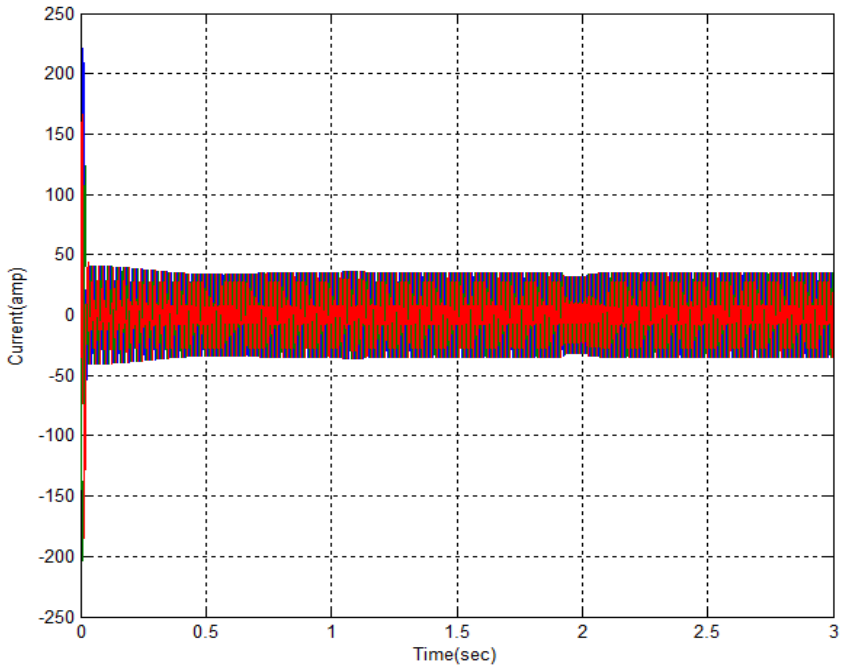

Figure 4.19stator current when applying load(30N-M)at1sec and removing at 1.9sec.

It can be seen from the figures (4.14-4.19) while using the Fuzzy pi Controller the overshoots obtained are lesser as compared to the case when the PI Controller is used. The settling time is also less in case of the Fuzzy Logic Controller.

The torque plots show that while using the Fuzzy pi Controller oscillations occur during starting while the PI controller doesn't show any such characteristic. This is because the Fuzzy Logic Controller is based on random knowledge of data.

From the current plots, it can observe that in all the current plots the current is sinusoidal. But there is a distortion before the machine attains steady state. The reason for this, that during starting the machine passes through the unstable region.

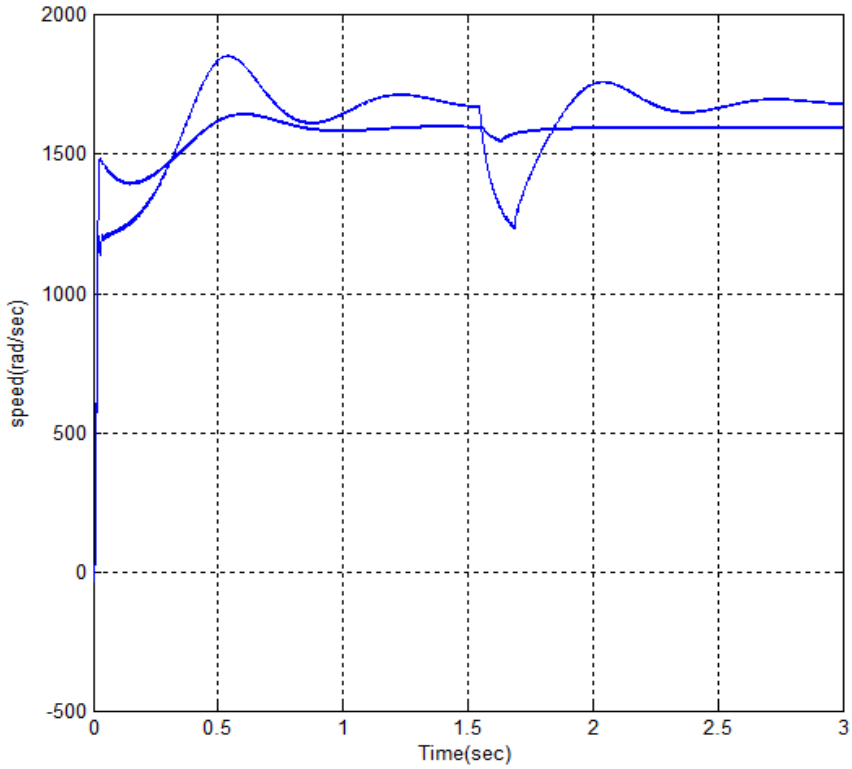

Figure 4.20Comparison between speed of fuzzy pi controller&pi controller when applying load at 1.5sec

Figure (4.20)shows the motor speed (when using fuzzy pi controller) goes dawn to1580rad/sec and settles at1.9sec, while the speed (when using pi controller) goes dawn to1300rad/sec and settles after 2.9sec.

It is noted that, fuzzy pi controller gives less overshoot & settling Time compared with pi controller.