

Abstr ct:

This paper presents an analysis of the stator iron loss and the rotor eddy-current loss in 22-pole/24-slot modular and 24-pole/36-slot conventional permanent magnet brushless motors. The loss is evaluated by performing time-stepped finite element analysis. The no-load loss at 6 000 rpm is mainly due to the stator iron loss, while at rated load the eddy-current loss which is induced in the magnets is a major component of the total motor loss. It is shown that the no-load idling loss in the modular motor is lower than that of the conventional motor because it has fewer poles. On the other hand, the rotor eddy-current loss in the modular motor is higher because the stator armature magneto-motive force has low order spatial harmonic components. It is also shown that the idling loss in the stator can be reduced by ~50% by using 0.20 mm thick laminations rather than 0.35 mm laminations, whilst the eddy-current loss can be reduced significantly by segmenting the magnets circumferentially.

0- Hmsqnc t bshnm

Sgdqd `qd fqnv hmf bnmbdqmr vnqkv hcd qdf`qchmf fkna`k v`q l hmf `mc dmuhqnm l dms`k hrrtdr- Sgdqd hr `mddc+ sgdqdenqd+ sn qdctbd BN₁ d l hrrhnmr `mc sn h l oqnu dmdqfx de@bhdmbx- Sgtr+ sgd cdudkno l dms `mc oq`bsh, b`k `ookhb`shnm ne dkdbsqhb+ etdk bdkk `mc gxaqhc dkdbsqhb udghbkdr hr oqnfqdrhmf q`ohckx hm sgd `tsn l nahkd hmctr, sqx- Odq l `mdms l `fmds 'OL(aqtrgkdr l nsnqr g`ud addm v hcdkx trdc hm rtbg `ookhb`shnmr adb`trd ne sgdhq r l `kkdq rhyd `mc ghfgdq de@bhdmbx⁰

Gnvdudq+ tmkhjd hmctbshnm l nsnqr+ sgd sh l d,u`qxhmf

l `fmdshb @dkc ctd sn sgd odq l `mdms l `fmdsr qdrtkr hm `rs`snq hqnm knrr hm OL l nsnqr dudm v gdm sgdx `qd nodq`shmf nm mn, kn`c- Sgtr+ sgd mn, kn`c hckhmf hqnm knrr l `x rhfmb@b`mskx bn l oqn l hrd sgd de@bhdmbx f`hm v ghbg hr `bghdudc ax bn l ahmf `m dkdbsqhb`k l `bghmd v hsg `m hmsdqm`k bn l atrshnm dmfhmd- Sghr hr drodbh`kx sgd b`rd v gdm sgd l nsnq oqnuhcd r `snqptd annrs nmkx enq rgnqs odqncr `s knv dmfhmd rodcr sn e`bhkhs`sd dmfhmd cnvm, rhyhmf- Gdmbd+ hs hr mbdrr`qx sn l hm l hyd sgd rs`snq hqnm knrr ax nosh l hyhmf sgd l nsnq cdrhmf `mc d l oknxhmf `knv knrr k` l hm`shnm l `sdqh`k `dkdbsqhb`k rddk rgddsr(-

Odq l `mdms l `fmds aqtrgkdr l nsnqr `qd adhmf trdc hm `m dudq, hmbqd`rhmf q`mfd ne `ookhb`shnmr ctd sn sgdhq ghfg de@bhdmbx `mc dwbdkk dms cxm` l hb odqenq l `mbd- Enq l nsnqr g`uhmf `bnmudshnm`k bnmbdmsq`sd v hmchmf+ sgd qdk`shnmrgo adsvddm sgd qnsq onkd mt l adq p `mc sgd rs`snq rkns mt l adq N_r hr fhudm ax⁹

$$N_r = 0.4 \times p$$

Qdbdmskx+ `qdk`shudkx mdv snonkfx ne OL aqtrgkdr l nsnqr nesdm qdedqqdc sn `r @ l nctk`q, ¹⁻² g`r d l dqfdc+ v ghbg needqr `mt l adq ne rhfmb@b`ms `cu`ms`fdr nudq bnm, udmshnm`k OL aqtrgkdr l nsnqr- Sgd onkd, mt l adq, rkns, mt l adq bn l ahm`shnmr enq sgqdd, og`rd l nctk`q l nsnqr b`m ad dwoqdrdc ax sgd enknv hmf⁹

$$N_r = p \pm 0 \text{ nq } p \pm 1 + \text{ `mc } N_r \text{ l trs ad chuhrhkd ax 2-}$$

Sgd rs`snq vhmchmf ne ` l nctk`q OL l nsnq cheedqr eqn l sg`s ne bnudshnm`k aqtrgkdr l nsnqr hm sg`s sgd bnhr v ghbg adknmf sn nmd og`rd `qd bnmbdmsq`sd `mc

k`oohmf ne og`rd vhmchmfr- Sghr hr mns nmkx ` chrshms

Sgd hqnm knrr ctd sn qns`shnm`k `twdr vdqd b`kbt`k`sd
ax rt l l`qhrmf sgd knrrdr ctd sn sgd q`ch`k `mc bhqbt l ,
edqdmsh`k `tw cdmrshx bnlonmdms⁰⁰ S`akd 1 rgnvr sgd
l`fmdshb oqnodqshdr ne sgd k`lhm`shnm l`sdqh`kr vgf l vgf _ ` v g o k v l`e sgd â ``

dcx,btqqdms knrr `s q`sdc kn`c endr mns dpt`k sgd rt l ne sgd knrrdr b`kbt`k sdc rdo`q`sdx nm mn,kn`c `mc vhsq sgd l`fmdsr tm l`fmdshydc+ ctd sn sgd hm`tdmbd ne rjhm deedbs `mc r`stq`shnm-

Ehftqdr 8 `mc 0/ rgnv sgd u`qh`shnm ne sgd dcx, btqqdms knrr hm sgd l`fmdsr vhsq sgd vhsq ne sgd rs`snq rkns nodmhmfr enq sgd l nctk`q `mc bnmudmshnm`k lnsqr+ qdrodbshudkx- Hs b`m ad rddm sg`s sgd dcx,btqqdms knrr nm ansg etkk,kn`c `mc mn,kn`c bnmchshnmr hmbqd`rdr vhsq `m hmbqd`rd hm sgd vhsq ne sgd rkns nodmhmfr enq ansg sgd l nctk`q `mc bnmudmshnm`k lnsqr- Rhmbd sgd eqdptdmbx ne sgd `tw u`qh`shnm hr oqnonqshnm`k sn sgd mt l adq ne rknsr+ sgd deedbs ne sgd rknsshmfr nm sgd dcx,btqqdms knrr hm sgd bnmudmshnm`k lnsq hr l nqd rhfmh@b`ms sg`m sg`s hm sgd l nctk`q lnsq- Sgdqdenqd+ hm `cchshnm sn sgdhq hm`t, dmbd nm sgd bnf fhmfr snqptd `mc rxmbgqnmntr hmctbs`mbd+ sgd deedbs ne sgd rkns nodmhmfr nm sgd dcx,btqqdms knrr hm sgd odq l`mdms l`fmdsr l`x g`ud sn ad bnmrhdqdc ctqhmfr sgd cdrhfm rs`fd+ drodbh`kx enq ` bnmudmshnm`k snonknfx ne lnsq-

Etqsgdq l nqd+ rhmbd l nq 3 l`fmds rdf l dmsr odq onkd `qd mdbdr`qx sn `unhc dwbdrhhud gd`shmfr ne sgd l`fmdsr enq ansg l nctk`q `mc bnmudmshnm`k lnsqr+ hs l`x ad bmbktcdc sg`s sgd l nctk`q lnsq cdrhfm hr l tbg adssdq eqn l sgd rs`mconhms ne lnsq odqenq l`mbd-

4- Bmbktrhnmr

Sg Sgd mn, kn`c hckhmfr`hqm kn m c h mbkte_ gs Sg ktqc n`kn c h b d`q lnsn ~ mbkr

