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.

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Qebob ^ob dol tfkd `lk`bokp tloiatfab obd^oafkd dil_^i t^o jfkd ^ka bksfolk jbkq^i fpprbp+ Qebob fp ^ kbba) qebobclob) ql obar`b @L/ bjfppflkp ^ka ql fj molsb bkbodv bc^a`fbk`v+ Qerp) qeb absbilm jbkq ^ka mo^`qf* `^i ^mmif`^qflk lc bib`qof`) crbi `bii ^ka ev_ofa bib`qof` sbef`ibp fp moldobppfkd o^mfaiv fk qeb ^rql jl_fib fkarp* qov+ Mbo j^kbkq j^dkbq %MJ& _orpeibpp jlqlop e^sb _bbk tfabiv rpba fk pr`e ^mmif`^qflkp _b`^rpb lc qebfo pj^iibo pfwb ^ka efdebo bc^a`fbk`v·&+

Eltbsbo) rkifhb fkar`qflk jlqlop) qeb qfjb*s^ovfkd j^dkbqf` ^bia arb ql qeb mbo j^kbkq j^dkbqp obpriqp fk ^ pq^qlo folk ilpp fk MJ jlqlop bsbk tebk qebv ^ob lmbo^qfkd lk kl*il^a+ Qerp) qeb kl*il^a faifkd folk ilpp j^v pfdkf^a`^kqiv `ljmoljfpb qeb bc^a`fbk`v d^fk tef`e fp ^`efbsba _v `lj_fkfkd ^k bib`qof`^i j^`efkb tfqe ^k fkqbok^i `lj_rpqflk bkdfkb+ Qefp fp bpmb`f^iiv qeb `^pb tebk qeb jlqlo molsfabp ^ qlonrb _llpq lkiv clo peloq mboflap ^q ilt bkdfkb pmbbap ql c^`fifq^qb bkdfkb altk* pfwfkd+ Ebk`b) fq fp kb`bpp^ov ql jfkfj fwb qeb pq^qlo folk ilpp _v lmqfjfwfkd qeb jlqlo abpfdk ^ka bjmilvfkd ^ ilt ilpp i^jfk^qflk j^qbof^i %bib`qof`^i pqbbi pebbqp&+

Mbo j^kbkq j^dkbq _orpeibpp jlqlop ^ob _bfkd rpba fk ^k bsbo*fk`ob^pfkd o^kdb lc ^mmif`^qflkp arb ql qebfo efde bc^a`fbk`v ^ka bu`biibkq avk^jf` mboclo j^k`b+ Clo jlqlop e^sfkd ^ `lksbkqflk^i `lk`bkqo^qba tfkafkd) qeb obi^qflkpefm _bq tbbk qeb olqlo mlib krj_bo p ^ka qeb pq^qlo pilq krj_bo N_p fp dfsbk _v7

$$N_p = .+2 \times p$$

Ob`bkqiv) ^ obi^qfsbiv kbt qlmlildv lc MJ _orpeibpp jlqlo) lcqbk obcbooba ql ^p ¦jlari^o´/)0&) e^p bjbodba) tef`e lccbop ^ krj_bo lc pfdkf^a`^kq ^as^kq^dbp lsbo `lk* sbkqflk^i MJ _orpeibpp jlqlop+ Qeb mlib*krj_bo,pilq* krj_bo `lj_fk^qflkp clo qeobb*me^pb jlari^o jlqlop `^k _b bumobppba _v qeb cliil tfkd7

$$N_p = p \pm . \; lo\, p \pm /) \text{ ^ka } N_p \text{ jrpq } \_b \text{ afsfpf\_ib } \_v \; 0+$$

Qeb pq^qlo tfkafkd lc ^ jlari^o MJ jlqlo afccbop col j qe^q lc `lksbkqflk^i _orpeibpp jlqlop fk qe^q qeb `lfip tef`e _bilkd ql lkb me^pb ^ob `lk`bkqo^qba ^ka

i^mmfkd lc me^pb t fkafkdp+ Qefp fp klq lkiv ^ afpqfk`q

Qeb folk ilpp arb ql olq^qflk^i «rubp tbob `^i`ri^qba
_v pr j j ^ofpfkd qeb ilppbp arb ql qeb o^af^i ^ka `fo`r j *
cbobkqf^i «ru abkpfqv `l j mlkbkqp··&+ **Q^_ib** / pel t p qeb
j ^dkbqf` molmboqfbp lc qeb i^ j fk^qflk j ^qbof^ip tedj T tedJ m ^ te m it j ^c qeb _^ ~ ^^

baav*`roobkq ilpp ^q o^qba il^a albp klq bnr^i qeb pr j lc qeb ilppbp `^i`ri^qba pbm^o^qbiv lk kl*il^a ^ka tfqe qeb j ^dkbqp rk j ^dkbqfwba) arb ql qeb fk«rbk`b lc phfk bccb`q ^ka p^qro^qflk+

Cfdrobp 6 ^ka **.-** pel t qeb s^of^qflk lc qeb baav*`roobkq ilpp fk qeb j ^dkbqp tfqe qeb tfaqe lc qeb pq^qlo pilq lmbkfkdp clo qeb j lari^o ^ka `lksbkqflk^i j lqlop) obpmb`qfsbiv+ Fq `^k _b pbbk qe^q qeb baav*`roobkq ilpp lk _lqe crii*il^a ^ka kl*il^a `lkafqflkp fk`ob^pbp tfqe ^k fk`ob^pb fk qeb tfaqe lc qeb pilq lmbkfkdp clo _lqe qeb j lari^o ^ka `lksbkqflk^i j lqlop+ Pfk`b qeb cobnrbk`v lc qeb «ru s^of^qflk fp molmloqflk^i ql qeb kr j _bo lc pilqp) qeb bccb`q lc qeb pilqqfkd lk qeb baav*`roobkq ilpp fk qeb `lksbkqflk^i j lqlo fp j lob pfdkfª`^kq qe^k qe^q fk qeb j lari^o j lqlo+ Qebobclob) fk ^aafqflk ql qebfo fk«rbk`b lk qeb `lddfkd qlonrb ^ka pvk`eolklrp fkar`q^k`b) qeb bccb`q lc qeb pilq lmbkfkdp lk qeb baav*`roobkq ilpp fk qeb mbo j ^kbkq j ^dkbqp j ^v e^sb ql _b `lkpfaboba arofkd qeb abpfdk pq^db) bpmb`f^iiv clo ^ `lksbkqflk^i qlmlildv lc j lqlo+

Croqebo j lob) pfk`b / lo 1 j ^dkbq pbd j bkqp mbo mlib ^ob kb`bpp^ov ql ^slfa bu`bppfsb eb^qfkd lc qeb j ^dkbqp clo _lqe j lari^o ^ka `lksbkqflk^i j lqlop) fq j ^v _b `lk`iraba qe^q qeb j lari^o j lqlo abpfdk fp j r`e _bqqbo col j qeb pq^kamlfkq lc j lqlo mboclo j ^k`b+

2+ @lk`irpflkp

Qe ¡ Qeb Ml*fq ^a fa ifkda ^l ^folk il k a ÿ f ě k`irc ] eq Qe ¡ ⅜ iroa l^il a ÿ f ě ` b^o j lql | k`ip