Durability Tests of Ball Screw Assembly for the CEDM

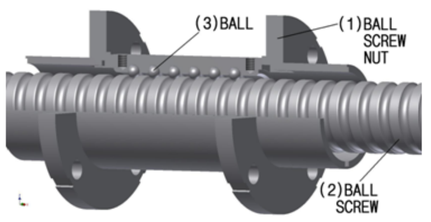
Choi Myoung-Hwan, Jang Young-Eun, Kong Jungpyo, Lee Jihoon(KAERI)

◆ Overview

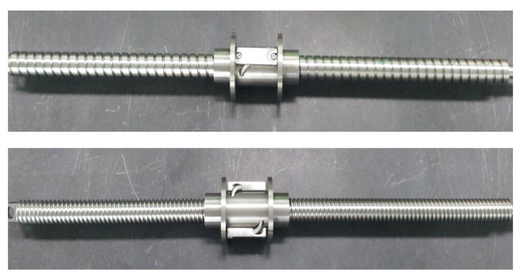
- ✓ Control Element Drive Mechanism(CEDM) is a device to control the position of a control element assembly.
- ✓ For the integral reactor, the ball-screw type CEDM driven by a stepping motor was developed, and the performance of ball screw assembly has been improving through a lot of efforts.
- ✓ This paper describes the durability test results of ball screw assemblies made of Cronidur30 and XM16 materials.

◆ Durability Test

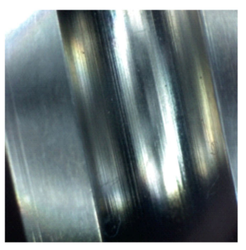
- ✓ Configuration of ball screw assembly:
  - Ball screw shaft, ball nut, balls and transferring tube
- ✓ Materials: Shaft/ball nut - Cronidur30, XM16, Ball - Si_3N_4
- ✓ 6 Test specimens:
  - Single-row and double-row according to the combination of materials and heat treatment conditions
- ✓ Test device: Simultaneous testing of 2 specimens in water
- ✓ Test requirements and method:
  - Applied load(upward on the ball nut): 250 kgf under water
  - Travel distance of ball but: 10 km (670,000 rotations)
  - Rotating speed: 60 rpm
  - Tests were performed by the continuous up-and-down driving of the ball nut

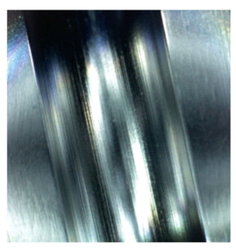


Config. of ball screw assembly



(Top; Single-row, Bot.; Double-row)
Test specimen





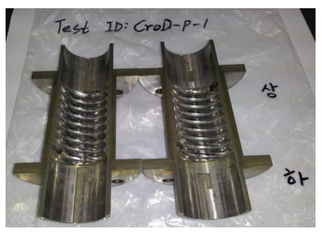
(a) Before (b) After
Shaft groove of peened Cro30

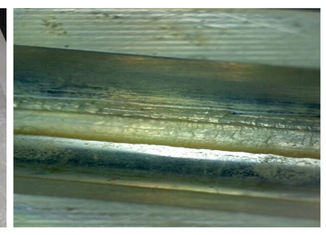


Durability test device

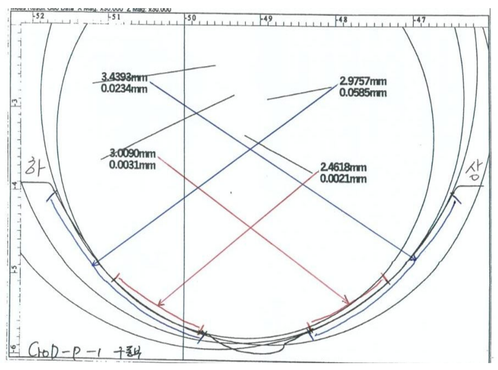
◆ Results and Discussion

- ✓ Measured items during or before/after the test
  - Pre-load, ball diameter, BCD, torque, sound
- ✓ The results were evaluated based on the 10 km run, the occurrence of flaking, a mount of wear and rapid variation of torque and sound during the test.
- ✓ Change of dimension and pre-load after the test
  - Ball diameter was changed in the range of 22–63μm.
  - BCD of the shaft groove was decreased by 2–9μm.
  - Pre-load of the single row specimen did not remain.
- ✓ Wear of balls and grooves
  - Single-row(CroS) > Double-row(CroD)
  - Ball nut > shaft
- ✓ No rapid change in torque and sound during the test
- ✓ No flaking in groove of all specimens after the test
- ✓ Double-row ball screw shown more good performances than those of single-row.





(a) Sec. view (b) Groove
Ball nut after the test (peened Cro30)



Measured results of the ball nut groove

Summary of test results

Test ID	Ball dia. change (μm)	BCD change (μm)	Avg. torque (kgf.cm)	Pre-load (kgf.cm)	Sound (db)
CroS-H-1*	-63	-9	7.50	0	69.8
CroS-H-2	-58	-8	7.99	0	68.6
CroD-H-1	-36	-4	9.60	0~0.3	69.8
CroD-H-2	-22	-7	8.98	0.5~0.8	68.9
CroD-P-1	-34	-2	8.98	0.4~1.1	68.9
XMD-QT-1	-41	-4	5.43	0~0.3	68.5

Note : * CroS-H-1(Cronidur30 Single-Hardening-No.),
Ball material : Si_3N_4, Initial pre-load : 1.0~3.0 kgf.cm

◆ Conclusions

- ✓ A durability test for 6 ball screw assemblies was performed, and test results met the driving requirements of 10 km without any rapid changes of torque and flaking of ball nut groove.
- ✓ The wear of double-row ball screw assembly was lower than the single-row one.
- ✓ The results for Cronidur30 ball screw specimens were similar to or slightly better than those of XM16.