

Acta Crystallographica Section E

Structure Reports

Online

ISSN 1600-5368

Bis[μ -5-(5-carboxylato-3-pyridyl)tetrazolato- $\kappa^3 N^1, N^5: N^2$]bis[triaquazinc(II)]

 Haoyong Yin,^{a*} Ling Wang^b and Qiulin Nie^a
^aInstitute of Environmental Science and Engineering, Hangzhou Dianzi University, Hangzhou 310018, People's Republic of China, and ^bCollege of Chemistry and Chemical Engineering, Xinyang Normal University, Xinyang 464000, People's Republic of China

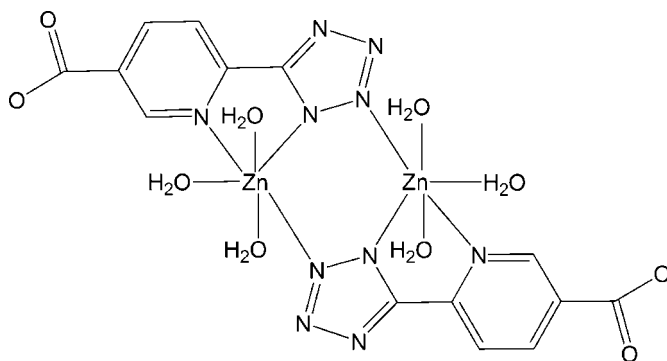
Correspondence e-mail: yhy@hdu.edu.cn

Received 7 March 2009; accepted 16 March 2009

 Key indicators: single-crystal X-ray study; $T = 295$ K; mean $\sigma(C-C) = 0.003$ Å; R factor = 0.032; wR factor = 0.064; data-to-parameter ratio = 13.4.

In the title complex, $[Zn_2(C_7H_3N_5O_2)_2(H_2O)_6]$, the 5-(5-carboxylato-3-pyridyl)tetrazolate ligand chelates the Zn^{II} center through one pyridyl N and one tetrazolate N atom, and uses another N atom to bridge to the second Zn atom, forming a centrosymmetric dinuclear unit. Three coordinated water molecules complete the distorted octahedral geometry of the Zn^{II} atom. $O-H\cdots O$ and $O-H\cdots N$ hydrogen bonds involving the coordinated water molecules, tetrazolate N atoms and the carboxylate group result in a three-dimensional structure.

Related literature

 For background, see: Li *et al.* (2005); Sun *et al.* (2009).


Experimental

Crystal data

 $[Zn_2(C_7H_3N_5O_2)_2(H_2O)_6]$
 $M_r = 617.12$

 Monoclinic, $P2_1/c$
 $a = 12.751$ (5) Å

 $b = 12.685$ (4) Å

 $c = 6.992$ (3) Å

 $\beta = 104.914$ (4)°

 $V = 1092.9$ (7) Å³
 $Z = 2$

 Mo $K\alpha$ radiation

 $\mu = 2.27$ mm⁻¹
 $T = 295$ K

 $0.12 \times 0.08 \times 0.08$ mm

Data collection

Rigaku Mercury CCD diffractometer

 Absorption correction: multi-scan (*CrystalClear*; Rigaku, 2000)

 $T_{\min} = 0.880$, $T_{\max} = 1.000$

(expected range = 0.734–0.834)

8378 measured reflections

2502 independent reflections

 2146 reflections with $I > 2\sigma(I)$
 $R_{\text{int}} = 0.031$

Refinement

 $R[F^2 > 2\sigma(F^2)] = 0.032$
 $wR(F^2) = 0.064$
 $S = 1.10$

2502 reflections

187 parameters

6 restraints

H atoms treated by a mixture of independent and constrained refinement

 $\Delta\rho_{\text{max}} = 0.44$ e Å⁻³
 $\Delta\rho_{\text{min}} = -0.31$ e Å⁻³

Table 1

Selected geometric parameters (Å, °).

Zn1–O3	2.0547 (18)	Zn1–N5 ⁱ	2.1333 (19)
Zn1–O5	2.0587 (19)	Zn1–N2	2.1470 (18)
Zn1–O4	2.1317 (18)	Zn1–N1	2.2114 (19)
O3–Zn1–O5	92.12 (8)	O5–Zn1–O4	177.71 (8)
O3–Zn1–O4	85.92 (7)		

 Symmetry code: (i) $-x, -y + 1, -z$.

Table 2

Hydrogen-bond geometry (Å, °).

$D-H\cdots A$	$D-H$	$H\cdots A$	$D\cdots A$	$D-H\cdots A$
O4–H4B \cdots O2 ⁱⁱ	0.846 (10)	1.942 (11)	2.782 (3)	172 (3)
O4–H4A \cdots N3 ⁱⁱⁱ	0.841 (10)	2.110 (11)	2.940 (3)	169 (3)
O3–H3B \cdots O1 ⁱⁱ	0.849 (10)	1.875 (12)	2.712 (3)	169 (3)
O3–H3A \cdots O1 ^{iv}	0.846 (10)	1.880 (11)	2.719 (2)	171 (3)
O5–H5B \cdots O1 ^v	0.844 (10)	1.922 (13)	2.740 (3)	163 (3)
O5–H5A \cdots N4 ^{vi}	0.841 (10)	1.960 (10)	2.800 (3)	177 (3)

 Symmetry codes: (ii) $-x + 1, -y + 1, -z$; (iii) $x, -y + \frac{3}{2}, z - \frac{1}{2}$; (iv) $-x + 1, y - \frac{1}{2}, -z + \frac{1}{2}$; (v) $-x + 1, -y + 1, -z + 1$; (vi) $-x, y - \frac{1}{2}, -z + \frac{1}{2}$.

Data collection: *CrystalClear* (Rigaku, 2000); cell refinement: *CrystalClear*; data reduction: *CrystalClear*; program(s) used to solve structure: *SHELXS97* (Sheldrick, 2008); program(s) used to refine structure: *SHELXL97* (Sheldrick, 2008); molecular graphics: *X-SEED* (Barbour, 2001); software used to prepare material for publication: *SHELXL97*.

The authors acknowledge financial support from Zhejiang Provincial Natural Science Foundation of China (Y4080093 and Y407189).

Supplementary data and figures for this paper are available from the IUCr electronic archives (Reference: NG2558).

References

- Barbour, L. J. (2001). *J. Supramol. Chem.* **1**, 189–191.
 Li, J.-T., Tao, J., Huang, R.-B. & Zhang, L.-S. (2005). *Acta Cryst.* **E61**, m984–m985.
 Rigaku (2000). *CrystalClear*. Rigaku Corporation, Tokyo, Japan.
 Sheldrick, G. M. (2008). *Acta Cryst.* **A64**, 112–122.
 Sun, Z.-H., Meng, L.-B. & Lin, H. (2009). *Acta Cryst.* **E65**, m280.

supplementary materials

Acta Cryst. (2009). E65, m425 [doi:10.1107/S1600536809009660]

Bis[μ -5-(5-carboxylato-3-pyridyl)tetrazolato- $\kappa^3 N^1, N^5: N^2$]bis[triaquazinc(II)]

H. Yin, L. Wang and Q. Nie

Comment

Metal complexes based on tetrazol ligands have attracted great interests (Li *et al.* 2005; Sun *et al.* 2009). In the contribution, we report the title binuclear complex (I) based on tetrazol ligand obtained by *in situ* ligand synthesis.

In the structure of (I), 3-carboxylatopyridyl-6-tetrazolato ligand chelates Zn^{II} center through one pyridyl N and one tetrazolato N and another bridging tetrazolato N atom results in a centrosymmetrical binuclear unit. Three coordinated water molecules complete the distorted octahedral geometry of Zn^{II} center (Fig.1). There exist various hydrogen-bonding interactions between coordinated water molecules and tetrazol N, carboxylate group of the ligand (Table. 2). The hydrogen bonds connect binuclear complex into a three-dimensional structure (Fig.2).

Experimental

A mixture of $Zn(NO_3)_2 \cdot 6H_2O$ (149 mg, 0.5 mmol), sodium azide(33 mg, 0.5 mmol) and 6-cyanopyridine-3-carboxylic acid (74 mg, 0.5 mmol) was suspended in water (10 ml) and heated in a teflon-lined steel bomb at 160 ° C for 3 days. The colorless crystals were obtained.

Refinement

H atoms bonded to C were located geometrically ($C-H = 0.95 \text{ \AA}$) with $U_{iso}(H) = 1.2 U_{eq}(C)$. H atoms bonded to O were located by difference maps and refined with a distance restraint of $O-H = 0.85 (1) \text{ \AA}$. The displacement factors were freely refined.

Figures

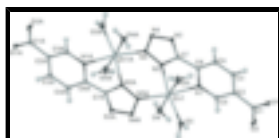


Fig. 1. ORTEP of complex (I) with 30% thermal ellipsoids. [Symmetry code: (A) $-x, 1-y, -z$.]

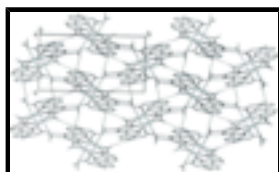


Fig. 2. The packing structure viewed along a axis.

Bis[μ -5-(5-carboxylato-3-pyridyl)tetrazolato- $\kappa^3 N^1, N^5: N^2$]bis[triazinc(II)]

Crystal data

[Zn₂(C₇H₃N₅O₂)₂(H₂O)₆]

$M_r = 617.12$

Monoclinic, $P2_1/c$

Hall symbol: -P 2ybc

$a = 12.751 (5) \text{ \AA}$

$b = 12.685 (4) \text{ \AA}$

$c = 6.992 (3) \text{ \AA}$

$\beta = 104.914 (4)^\circ$

$V = 1092.9 (7) \text{ \AA}^3$

$Z = 2$

$F_{000} = 624$

$D_x = 1.875 \text{ Mg m}^{-3}$

Mo $K\alpha$ radiation

$\lambda = 0.71073 \text{ \AA}$

Cell parameters from 2535 reflections

$\theta = 3.2\text{--}27.5^\circ$

$\mu = 2.27 \text{ mm}^{-1}$

$T = 295 \text{ K}$

Prism, colorless

$0.12 \times 0.08 \times 0.08 \text{ mm}$

Data collection

Rigaku Mercury CCD
diffractometer

Radiation source: fine-focus sealed tube

Monochromator: graphite

Detector resolution: $14.6306 \text{ pixels mm}^{-1}$

$T = 295 \text{ K}$

CCD_Profile_fitting scans

Absorption correction: Multi-scan
(CrystalClear; Rigaku, 2000)

$T_{\min} = 0.880$, $T_{\max} = 1.000$

8378 measured reflections

2502 independent reflections

2146 reflections with $I > 2\sigma(I)$

$R_{\text{int}} = 0.031$

$\theta_{\max} = 27.5^\circ$

$\theta_{\min} = 2.3^\circ$

$h = -13 \rightarrow 16$

$k = -16 \rightarrow 13$

$l = -9 \rightarrow 8$

Refinement

Refinement on F^2

Least-squares matrix: full

$R[F^2 > 2\sigma(F^2)] = 0.032$

$wR(F^2) = 0.064$

$S = 1.10$

2502 reflections

187 parameters

6 restraints

Primary atom site location: structure-invariant direct
methods

Secondary atom site location: difference Fourier map

Hydrogen site location: inferred from neighbouring
sites

H atoms treated by a mixture of
independent and constrained refinement

$$w = 1/[\sigma^2(F_o^2) + (0.0236P)^2 + 0.4632P]$$

where $P = (F_o^2 + 2F_c^2)/3$

$(\Delta/\sigma)_{\max} = 0.001$

$\Delta\rho_{\max} = 0.44 \text{ e \AA}^{-3}$

$\Delta\rho_{\min} = -0.31 \text{ e \AA}^{-3}$

Extinction correction: none

Special details

Geometry. All e.s.d.'s (except the e.s.d. in the dihedral angle between two l.s. planes) are estimated using the full covariance matrix. The cell e.s.d.'s are taken into account individually in the estimation of e.s.d.'s in distances, angles and torsion angles; correlations between e.s.d.'s in cell parameters are only used when they are defined by crystal symmetry. An approximate (isotropic) treatment of cell e.s.d.'s is used for estimating e.s.d.'s involving l.s. planes.

Refinement. Refinement of F^2 against ALL reflections. The weighted R -factor wR and goodness of fit S are based on F^2 , conventional R -factors R are based on F , with F set to zero for negative F^2 . The threshold expression of $F^2 > \sigma(F^2)$ is used only for calculating R -factors(gt) *etc.* and is not relevant to the choice of reflections for refinement. R -factors based on F^2 are statistically about twice as large as those based on F , and R -factors based on ALL data will be even larger.

Fractional atomic coordinates and isotropic or equivalent isotropic displacement parameters (\AA^2)

	<i>x</i>	<i>y</i>	<i>z</i>	$U_{\text{iso}}^*/U_{\text{eq}}$
Zn1	0.16114 (2)	0.451195 (18)	0.04261 (4)	0.01891 (9)
N1	0.29843 (15)	0.55236 (13)	0.1954 (3)	0.0199 (4)
O2	0.62383 (14)	0.48266 (13)	0.2838 (3)	0.0345 (4)
O1	0.67185 (13)	0.64838 (12)	0.3616 (2)	0.0273 (4)
N2	0.08352 (15)	0.59050 (14)	0.1144 (3)	0.0184 (4)
C1	0.60194 (19)	0.57469 (18)	0.3163 (3)	0.0219 (5)
C4	0.3458 (2)	0.72742 (18)	0.3169 (4)	0.0258 (5)
H4	0.3239	0.7953	0.3491	0.031*
C6	0.26966 (19)	0.65036 (16)	0.2412 (3)	0.0196 (5)
C3	0.4544 (2)	0.70372 (18)	0.3447 (4)	0.0260 (5)
H3	0.5079	0.7557	0.3958	0.031*
C2	0.48558 (18)	0.60427 (17)	0.2980 (3)	0.0193 (5)
C5	0.40336 (19)	0.53119 (17)	0.2249 (3)	0.0217 (5)
H5	0.4236	0.4624	0.1944	0.026*
O3	0.26729 (15)	0.34205 (13)	-0.0178 (3)	0.0278 (4)
O4	0.16780 (16)	0.52386 (13)	-0.2289 (3)	0.0277 (4)
C7	0.15272 (19)	0.66661 (16)	0.1971 (3)	0.0184 (5)
O5	0.16098 (16)	0.37901 (15)	0.3062 (3)	0.0353 (5)
N5	-0.01525 (15)	0.63182 (14)	0.0916 (3)	0.0195 (4)
N4	-0.00558 (16)	0.72963 (15)	0.1574 (3)	0.0250 (4)
N3	0.09973 (16)	0.75412 (15)	0.2242 (3)	0.0245 (4)
H4A	0.141 (2)	0.5845 (12)	-0.254 (4)	0.041 (9)*
H3A	0.289 (2)	0.2851 (13)	0.042 (4)	0.040 (8)*
H4B	0.2293 (14)	0.527 (2)	-0.254 (5)	0.047 (9)*
H3B	0.279 (2)	0.339 (2)	-0.132 (2)	0.045 (9)*
H5A	0.114 (2)	0.336 (2)	0.320 (5)	0.058 (10)*
H5B	0.2086 (18)	0.383 (2)	0.415 (2)	0.040 (8)*

Atomic displacement parameters (\AA^2)

	U^{11}	U^{22}	U^{33}	U^{12}	U^{13}	U^{23}
Zn1	0.01593 (16)	0.01373 (14)	0.02694 (15)	-0.00018 (10)	0.00528 (11)	-0.00126 (10)

supplementary materials

N1	0.0160 (10)	0.0159 (9)	0.0274 (10)	-0.0006 (7)	0.0051 (8)	-0.0027 (8)
O2	0.0210 (10)	0.0243 (9)	0.0606 (12)	0.0007 (7)	0.0146 (9)	-0.0065 (8)
O1	0.0170 (9)	0.0271 (9)	0.0372 (10)	-0.0048 (7)	0.0059 (8)	-0.0073 (7)
N2	0.0140 (10)	0.0172 (9)	0.0240 (10)	0.0005 (7)	0.0051 (8)	-0.0017 (7)
C1	0.0166 (13)	0.0276 (13)	0.0222 (12)	-0.0001 (9)	0.0061 (10)	-0.0008 (9)
C4	0.0196 (13)	0.0194 (11)	0.0382 (14)	0.0004 (9)	0.0071 (11)	-0.0072 (10)
C6	0.0188 (13)	0.0170 (11)	0.0228 (11)	0.0007 (9)	0.0051 (10)	-0.0022 (9)
C3	0.0206 (13)	0.0215 (12)	0.0344 (14)	-0.0052 (10)	0.0042 (11)	-0.0072 (10)
C2	0.0146 (12)	0.0207 (11)	0.0222 (12)	-0.0003 (9)	0.0039 (9)	-0.0007 (9)
C5	0.0173 (13)	0.0192 (11)	0.0288 (12)	0.0011 (9)	0.0063 (10)	-0.0016 (9)
O3	0.0332 (11)	0.0185 (9)	0.0347 (10)	0.0079 (7)	0.0141 (9)	0.0029 (8)
O4	0.0258 (11)	0.0238 (9)	0.0367 (10)	0.0053 (7)	0.0139 (9)	0.0075 (8)
C7	0.0168 (12)	0.0167 (10)	0.0218 (11)	-0.0013 (8)	0.0050 (9)	-0.0036 (9)
O5	0.0301 (12)	0.0394 (11)	0.0302 (10)	-0.0183 (9)	-0.0033 (9)	0.0129 (8)
N5	0.0135 (10)	0.0175 (9)	0.0273 (10)	0.0009 (7)	0.0050 (8)	-0.0028 (8)
N4	0.0185 (11)	0.0199 (10)	0.0363 (12)	0.0006 (8)	0.0067 (9)	-0.0077 (8)
N3	0.0170 (11)	0.0202 (10)	0.0353 (11)	0.0011 (8)	0.0048 (9)	-0.0089 (8)

Geometric parameters (\AA , $^\circ$)

Zn1—O3	2.0547 (18)	C6—C7	1.457 (3)
Zn1—O5	2.0587 (19)	C3—C2	1.386 (3)
Zn1—O4	2.1317 (18)	C3—H3	0.9500
Zn1—N5 ⁱ	2.1333 (19)	C2—C5	1.394 (3)
Zn1—N2	2.1470 (18)	C5—H5	0.9500
Zn1—N1	2.2114 (19)	O3—H3A	0.846 (10)
N1—C5	1.328 (3)	O3—H3B	0.849 (10)
N1—C6	1.358 (3)	O4—H4A	0.841 (10)
O2—C1	1.235 (3)	O4—H4B	0.846 (10)
O1—C1	1.274 (3)	C7—N3	1.338 (3)
N2—C7	1.335 (3)	O5—H5A	0.841 (10)
N2—N5	1.335 (2)	O5—H5B	0.844 (10)
C1—C2	1.504 (3)	N5—N4	1.318 (3)
C4—C3	1.381 (3)	N5—Zn1 ⁱ	2.1333 (19)
C4—C6	1.384 (3)	N4—N3	1.340 (3)
C4—H4	0.9500		
O3—Zn1—O5	92.12 (8)	N1—C6—C7	113.79 (19)
O3—Zn1—O4	85.92 (7)	C4—C6—C7	124.1 (2)
O5—Zn1—O4	177.71 (8)	C4—C3—C2	120.2 (2)
O3—Zn1—N5 ⁱ	97.06 (7)	C4—C3—H3	119.9
O5—Zn1—N5 ⁱ	88.43 (7)	C2—C3—H3	119.9
O4—Zn1—N5 ⁱ	92.97 (7)	C3—C2—C5	117.2 (2)
O3—Zn1—N2	166.01 (7)	C3—C2—C1	122.9 (2)
O5—Zn1—N2	92.86 (8)	C5—C2—C1	119.8 (2)
O4—Zn1—N2	88.79 (7)	N1—C5—C2	123.7 (2)
N5 ⁱ —Zn1—N2	96.13 (7)	N1—C5—H5	118.1
O3—Zn1—N1	90.51 (7)	C2—C5—H5	118.1
O5—Zn1—N1	90.49 (7)	Zn1—O3—H3A	128.6 (19)

O4—Zn1—N1	88.35 (7)	Zn1—O3—H3B	121 (2)
N5 ⁱ —Zn1—N1	172.39 (7)	H3A—O3—H3B	108 (3)
N2—Zn1—N1	76.39 (7)	Zn1—O4—H4A	118.2 (19)
C5—N1—C6	118.12 (19)	Zn1—O4—H4B	117 (2)
C5—N1—Zn1	126.76 (14)	H4A—O4—H4B	105 (3)
C6—N1—Zn1	114.64 (15)	N2—C7—N3	111.1 (2)
C7—N2—N5	105.42 (17)	N2—C7—C6	121.04 (19)
C7—N2—Zn1	113.79 (15)	N3—C7—C6	127.8 (2)
N5—N2—Zn1	140.58 (14)	Zn1—O5—H5A	124 (2)
O2—C1—O1	124.2 (2)	Zn1—O5—H5B	128 (2)
O2—C1—C2	119.0 (2)	H5A—O5—H5B	108 (3)
O1—C1—C2	116.8 (2)	N4—N5—N2	109.10 (17)
C3—C4—C6	118.7 (2)	N4—N5—Zn1 ⁱ	127.65 (14)
C3—C4—H4	120.7	N2—N5—Zn1 ⁱ	123.21 (13)
C6—C4—H4	120.7	N5—N4—N3	109.59 (17)
N1—C6—C4	122.1 (2)	C7—N3—N4	104.80 (18)

Symmetry codes: (i) $-x, -y+1, -z$.

Hydrogen-bond geometry ($\text{\AA}, ^\circ$)

$D-H\cdots A$	$D-H$	$H\cdots A$	$D\cdots A$	$D-H\cdots A$
O4—H4B \cdots O2 ⁱⁱ	0.846 (10)	1.942 (11)	2.782 (3)	172 (3)
O4—H4A \cdots N3 ⁱⁱⁱ	0.841 (10)	2.110 (11)	2.940 (3)	169 (3)
O3—H3B \cdots O1 ⁱⁱ	0.849 (10)	1.875 (12)	2.712 (3)	169 (3)
O3—H3A \cdots O1 ^{iv}	0.846 (10)	1.880 (11)	2.719 (2)	171 (3)
O5—H5B \cdots O1 ^v	0.844 (10)	1.922 (13)	2.740 (3)	163 (3)
O5—H5A \cdots N4 ^{vi}	0.841 (10)	1.960 (10)	2.800 (3)	177 (3)

Symmetry codes: (ii) $-x+1, -y+1, -z$; (iii) $x, -y+3/2, z-1/2$; (iv) $-x+1, y-1/2, -z+1/2$; (v) $-x+1, -y+1, -z+1$; (vi) $-x, y-1/2, -z+1/2$.

Fig. 1

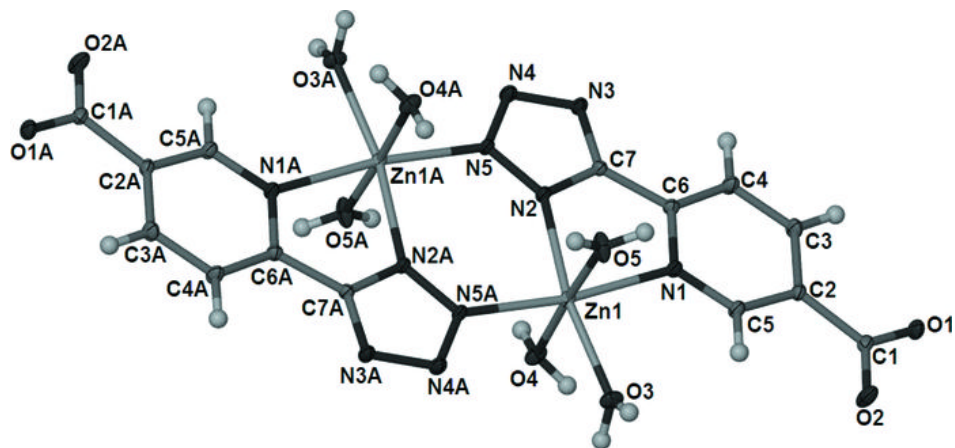


Fig. 2

